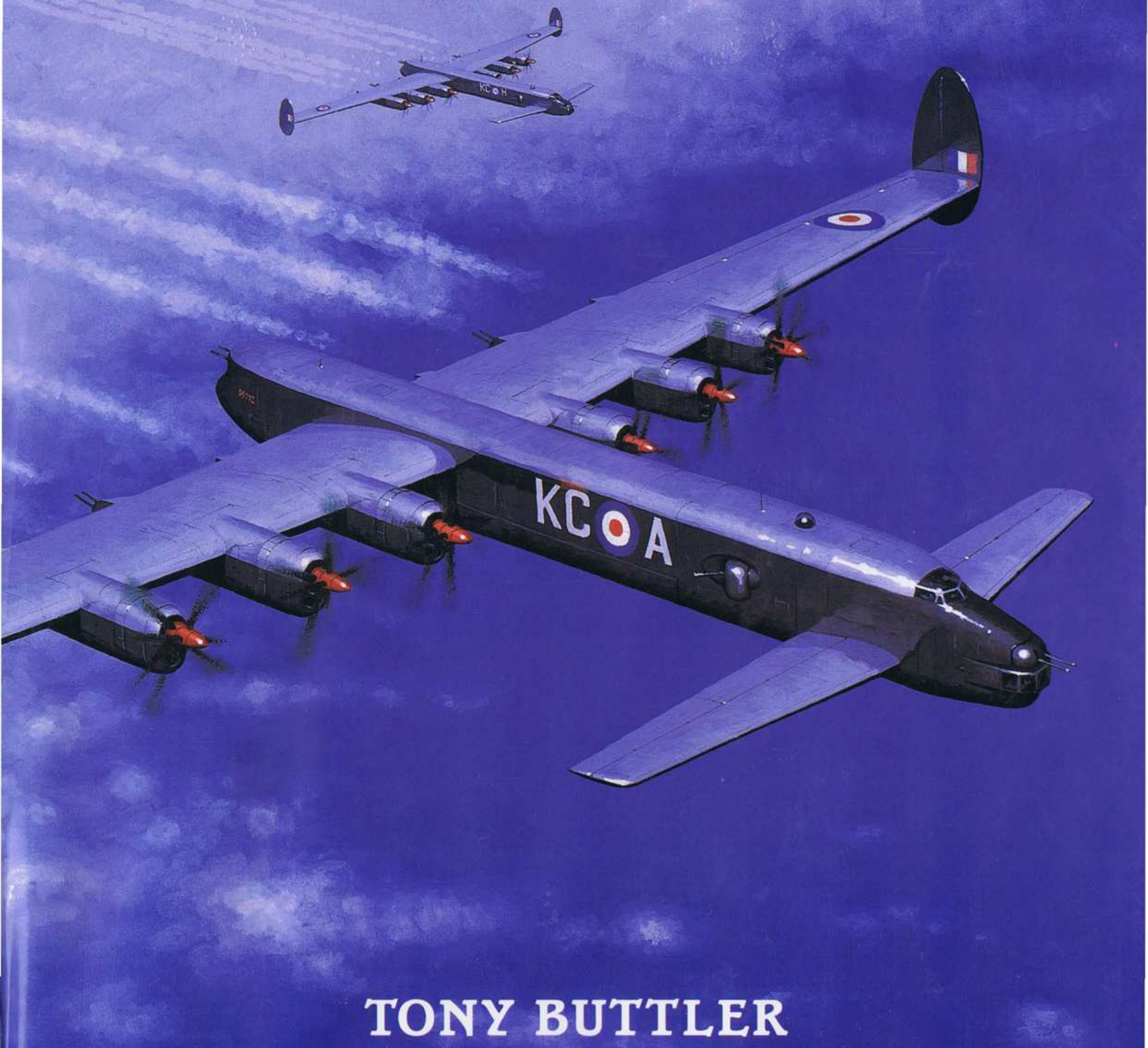
BRITISH SECRET PROJECTS

FIGHTERS & BOMBERS 1935-1950



TONY BUTTLER

BRITISH
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FIGHTERS & BOMBERS
1935-1950

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TONY BUTTLER

MIDLAND
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To the designers, engineers and
pilots who created these fascinating
aeroplanes and projects

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Fighters & Bombers 1935-1950
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Westland Welkin DX318 banks towards the camera.
Fred Ballam, Westland

Photograph on title page:
Hawker Typhoon R7700. BAE Systems

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Introduction and Acknowledgements

This volume completes a trilogy of *British Secret Projects* titles that covers the design and development of British fighters and bombers from approximately the end of the biplane era to the start of the new millennium. The sub-title dates, 1935 to 1950, embrace the rearmament period right through to the last first flights of types developed during the war. In other words the book begins with projects prepared in the knowledge that war was probably coming and ends with some aircraft which were essentially wartime designs, such as the Venom and Sea Hawk, but which did not get airborne until after the conflict had ended. In fact the Venom did not fly until 1949 but, as a development of the Vampire, it is fully representative of wartime aerodynamics, structure and technology. Perhaps the Hawker Sea Hawk, with its bifurcated intake and jetpipes developed specifically to solve the problems of jet propulsion, represents the last word in World War Two technology and thus connects this volume to the post-1950 books.

Finding a demarcation line has been difficult and some readers may disagree with the decision to omit, or discuss only briefly, some 1933/34 period designs. However, an official post-war report noted that 'even the pre-1936 heavy and medium bombers (such as the Whitley and Hampden) could only partially be adapted to 1938 standards'. The Whitley was depicted as being 'still too slow and lumbering', and so I feel that a more thorough coverage of such aeroplanes really belongs to a review of 1920s and early 1930s developments. Once war had broken out some of the pre-war ideas, such as the turret fighter, were found to be flawed, but they still form an important part of the story.

Certain post-war flying boat projects proposed in the late 1940s for service in the 1950s are also mentioned briefly. Had any of these types been put into service they should have carried 1950s weaponry but when they were designed the concept of the large military flying boat had become out of date, so they were omitted from the post-war fighter and bomber volumes and held back until now. I have tried to ensure that each chapter describes a specific category of aeroplane but at times there has been some overlap, for example similar RAF and RN requirements, single and twin-engined fighters in competition, light/medium bombers, so when this happens the projects concerned are described in the most convenient place.

Once again extensive use has been made of previously unpublished primary source material held by museums and record offices and in company and private collections. Much of this has actually been declassified for twenty or thirty years but rarely accessed by researchers, often because it was previously inaccessible. To keep in line with the earlier volumes, particular emphasis was yet again placed on the design competitions between projects from different companies; however the war did witness a good number of types put into the air with little or no competition and jet aircraft are perhaps the best example of this.

Sadly, unlike the overall situation for post-war British projects, many designs from World War Two and before have now been lost forever. In some cases archives stored 'for safe keeping' during the war were ruined while in store but, quite understandably, it also appears that some companies soon destroyed some of their piston aircraft archives because they had been made obsolete by the advent of the jet. Nevertheless many designs have survived and a high percentage of those reproduced here have never been published before; as a consequence they form the most complete record yet written. Project data throughout is the manufacturer's estimates; if submitted to the Ministry, the figures would normally be re-assessed by specialists and often changed (weights in particular would regularly increase) but using company data as much as possible provides a common factor to present the figures.

The interest which was generated by both of my previous books on British Secret Projects has been very pleasing and rewarding and has been very much appreciated. Completing this volume has been another fascinating and enjoyable experience and I hope those of you who sample it gain as much pleasure as I have in learning about these wonderful designs.

Acknowledgements

Once again I am greatly indebted to an enormous number of people who have helped me to put this work together. As before the lists of unbuilt projects in the Putnam series of books on British Aircraft Manufacturers, and selected other titles listed in the bibliography, gave the framework from which to begin my own research. After that I must thank the following for allowing me to raid their archives for information, drawings and photographs and for permission to publish material. I hope I've not forgotten anyone.

Peter Amos; Fred Ballam (Westland Yeovil); Alec Brew (Boulton Paul Association); David Charlton; Duncan Greenman (Bristol AirChive); George Cox; Ted Currier; Peter Elliot, Gordon Leith & Simon Moody of the RAF Museum; Ken Ellis (FlyPast); Steve Gillard & the staff of the BAe Brough Heritage Centre; Harry Fraser-Mitchell (Handley Page Association); Peter Green; Barry Guess and Mike Fielding of BAe Farnborough; Bill Harrison; Derek James; George Jenks (Avro Heritage); Roff Jones, Tim Kershaw & John Lewer of the Jet Age Museum; Brian Kervell; Roger Lindsay; Paul McMaster (Ulster Aviation Society); Jim Oughton; Barry Pegram; Public Record Office; Brian Riddle (Royal Aeronautical Society); Ray Sturtivant (Air-Britain); Chris Farara and Albert Kitchenside of the Brooklands Museum; Steve Thompson; Barry Wheeler (Air Pictorial) and Ray Williams.

In addition I am particularly grateful to Joe Cherrie and John Hall for offering to make models that filled gaps in my illustrations and to Phil Butler for the contracts list and for various photographs and other material. Special thanks also to Eric Morgan and Les Whitehouse for making available their archives and to Clive Richards of MoD Air Historical Branch for alerting me to details and sources which I had missed. I must also thank the team at Midland for their support and for completing another cracking production, and Keith Woodcock for his splendid front cover; once again it has been a pleasure to work with such quality folk.

Tony Buttler MA, AMRaeS, AMIM
Bretforton, December 2003

Chapter One

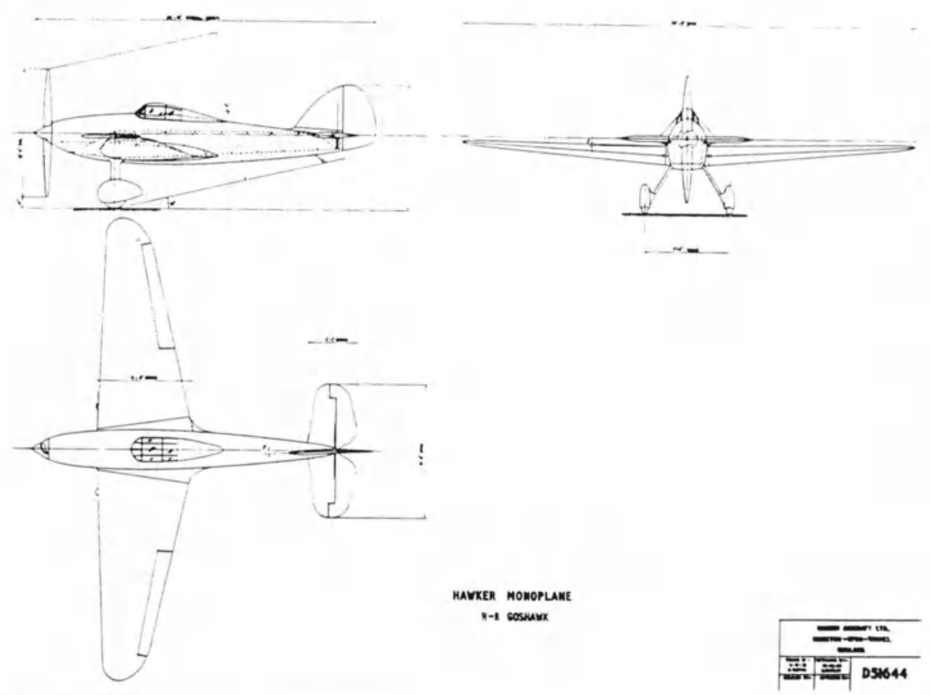
Single-Engined Fixed-Gun Fighters

Hawker Tempest 1 HM599. BAe Dunsfold

The most famous British fighter of World War Two has to be the Supermarine Spitfire; in fact, ahead of the Hurricane wartime fighter, Harrier jump jet and Concorde supersonic airliner, this is probably the most famous British aircraft of all time. The Spitfire's configuration, a single-seat high-performance aircraft with fixed machine guns or cannon all firing forward, is also the classic arrangement for a fighter, which has survived more or less to the present day. There were other types which were conceived before the Spitfire and Hurricane that served their country wonderfully throughout the war years, not least the Vickers Wellington bomber, but a survey of the unbuilt 'wartime' projects produced by the British aircraft industry has to begin somewhere and where better than these two fighters which did so much to win the Battle of Britain, and by doing so began the long haul that led to the defeat of Hitler's forces by the Allies.

In November 1934 the Air Staff produced Specification F.5/34 which called for a single-seat fighter capable of 275mph (442km/h) at 15,000ft (4,572m) and armed with six or eight 0.303in (7.7mm) Browning machine guns. The heavy gun armament represented a big increase over previous fighters, a move stimulated by the studies of Squadron Leader Ralph Sorley who had calculated that, with the speeds of the latest bombers approaching or exceeding that of current fighters, the chances of making more than one attacking pass were small. Consequently a much greater weight of fire was desirable for the short period that the fighter would be in contact with its target. By using eight 0.303in Browning machine guns a density of 256 rounds per second should be possible and a ground trial was staged with these guns which was convincing enough for the eight gun theory to be accepted. In addition the new fighter would be a monoplane which would bring to a close the great line of biplane fighters that had served the RAF for so long.

Sorley, in a paper written after the war, noted many of the factors that would be needed to make the new fighter work – the variable pitch propeller, a much higher all-up-weight (which some saw as a restriction after the biplane's usually exceptional manoeuvrability) and a considerable increase in landing speed over the biplane. These apparently

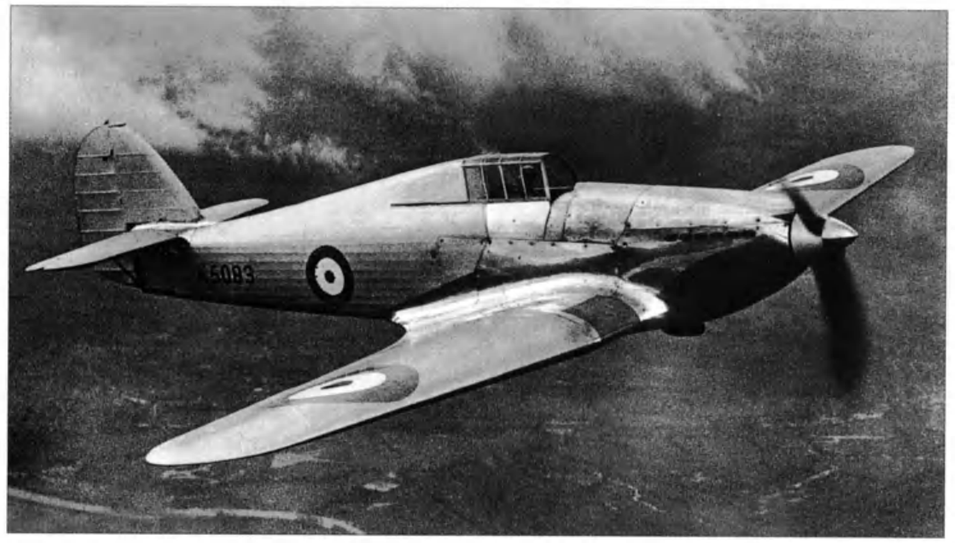


The Hawker 'Fury Monoplane', given the official title of 'Hawker Monoplane' fitted with a Goshawk engine (5.12.33).

simple steps were the results of a period of great discussion within the RAF and many officers were opposed to the new ideas. In the light of this and other controversial steps described in the following chapters, many aviation books and articles have suggested that the RAF and Air Staff were very slow in adopting new developments in military aircraft; in fact standard procedure has been to describe how the Air Staff was full of old men full of old ideas, all of whom were incapable of taking on anything new.

There is not time here to show how untrue this is, but the reader is advised to read Colin Sinnott's book *The Royal Air Force and Aircraft Design 1923-1939* to learn how the Air Staff was actually well acquainted with current advances in aviation and quickly worked them into a wide variety of new specifications and operational requirements. An example is the revelation that the three senior officers with the greatest influence on RAF aircraft procurement, Lord Trenchard, Cyril Newell and Sir John Higgins, were in favour of increasing fighter armament to at least four guns, or even six, as early as 1927. By 1934 the Air Staff and its various technical departments were very concerned by the growing superiority of fighters being developed abroad and they did not want the inferiority of contemporary British aircraft to persist during the period of rearmament. In July of that year the whole question of British fighter design against superior foreign products came under review and the development of the resulting ideas was reflected in the Air Staff's new fighter specifications, which demanded a much higher performance and technical superiority than their predecessors.

Returning to F.5/34, the first attempt to put heavily armed fighters with high performance into production actually proved unsuccessful. Vickers, Hawker, Bristol, Gloster and Westland were all invited to tender on 2nd January 1935 and prototypes were ordered for the Bristol 146, Gloster G.38 and Vickers 279 Venom, but by the time these entered flight test they had been overtaken by some potentially superior products from Hawker and Supermarine. Another specification, F.10/35, also included eight machines guns and high performance (310mph [499km/h] at 15,000ft [4,572m]) but, despite being circulated to industry and discussed in depth, this was never issued officially.

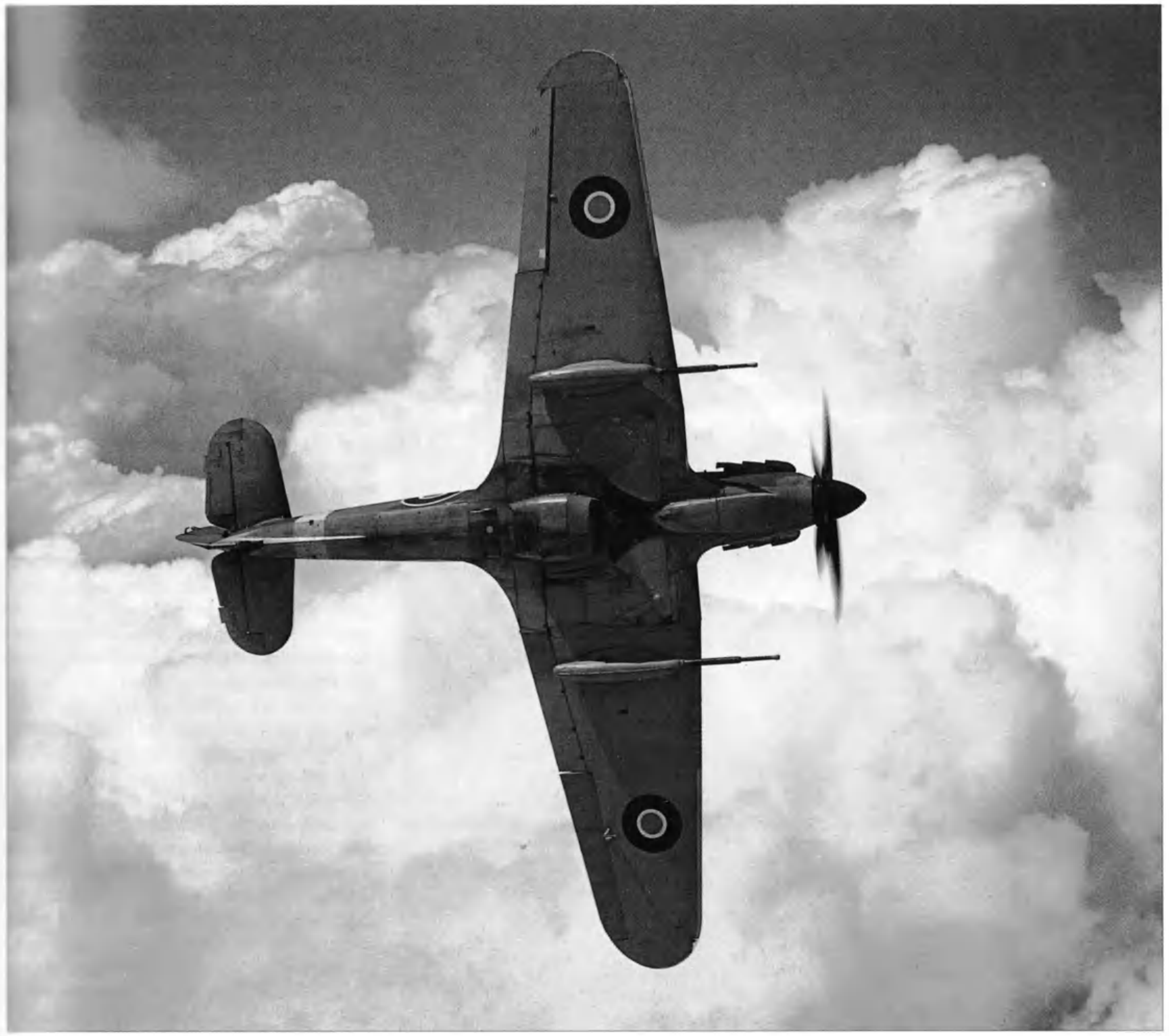


Hawker Hurricane prototype K5083.

Hawker Hurricane

During the first half of the 1930s Hawker Aircraft was fully occupied with the design and production of a highly successful family of biplane fighters and light bombers. This included the Fury fighter, the first production example of which flew on 26th March 1931. In August 1933 Hawker's Chief Designer Sydney Camm discussed with the Deputy Director of Technical Development (DDTD), Major Buchanan, the possibility of building a new type then known as the 'Fury Monoplane'. This would be armed with four machine guns, two in the fuselage and two in the wings, and powered by a Rolls-Royce Goshawk engine. Ahead of any official Ministry specification, a general layout drawing was completed on 5th December and on the 18th of that month it was discussed in detail with the Air Ministry's Capt. Liptrot.

In January 1934 the design was altered to take the new Rolls-Royce PV.12 engine (later called Merlin), which promised to outstrip contemporary engines from a power point of view, a feature which made it particularly suitable for fighters. Stressing of the 'Interceptor Monoplane', as it was now called, commenced in March and two months later working drawings were begun by the Experimental Drawing Office. At this stage the project was still a company private venture but the configuration had been refined and in July Buchanan was able to report that the preliminary design had been completed and Hawker was on the point of building a prototype. The full design was submitted to the Air Ministry on 4th September which now assumed responsibility for its development as an experimental type.

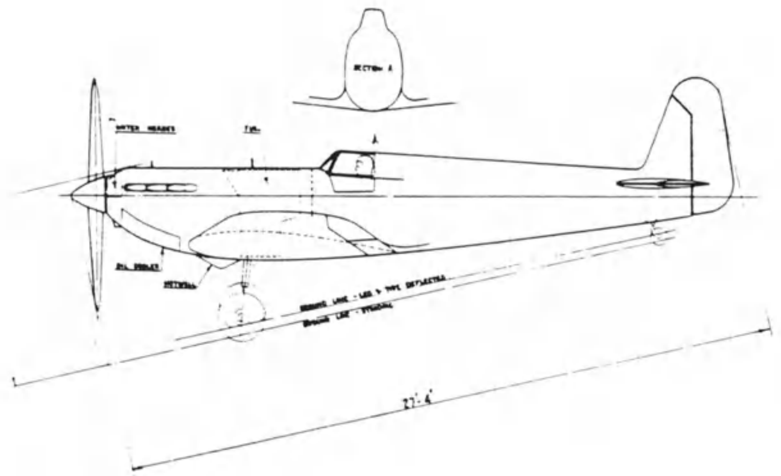


Ground attack Hurricane fitted with two 40mm guns.

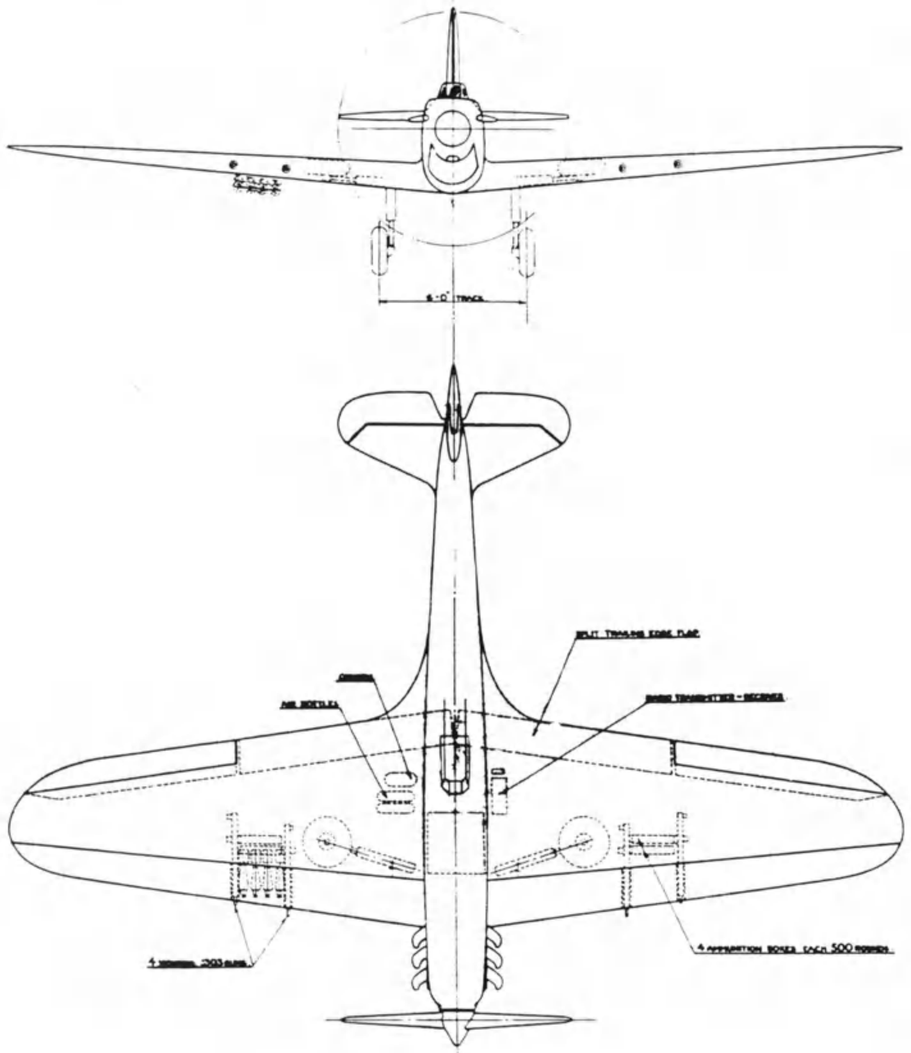
On 10th January 1935 a Mock-Up Conference with Air Ministry staff was held at Kingston and at 21st January the estimated maximum speed was 330mph (531km/h) at 15,000ft, based on a normal loaded weight of 4,900lb (2,223kg). An Air Ministry contract to purchase a prototype of the design submitted the previous September, against a new official specification F.36/34, was placed on 21st February and in April provision was to be made for two Vickers Mk.V guns housed in the fuselage with one Browning machine gun in each wing. Investigations into the construction of metal stressed skin outer wings began on 10th July (early Hurricanes had fabric-covered outer wings) and the contract was amended on 20th August to include another set of wings with eight guns (either Vickers or Brownings).

The prototype Hurricane, K5083, made its maiden flight on 6th November 1935 and official documents acknowledge the value of Hawker's private venture work on this aircraft as an important part of the Ministry's plans. Originally the company had hoped to fly K5083 in the spring of 1935 but some of the delay was caused by the Air Staff's desire to fit eight guns. Sorley had pointed out that that the mock-up F.36/34 and F.37/34 (the Spitfire) required few alterations to conform to F.10/35 and both Hawker and Supermarine were anxious to incorporate them.

However, certain technical problems needed to be solved and the biggest was how to mount the eight guns. To enable a fighter to obtain the best possible speed it was necessary to keep it as slim as possible, which made the fuselage size vitally important.



One of the most well known of British unbuilt aircraft designs is this early precursor to the Spitfire, the original Supermarine Type 300 with Goshawk engine and four guns (24.7.34).



Mounting the guns in the fuselage tended to increase the cross sectional area but the relatively thick monoplane wing offered a space where the guns might be mounted. A battery of four in each wing demanded a rigid structure and since the Hurricane wing was relatively thick the installation was somewhat easier than in the Spitfire's thinner wing. However, the Hurricane prototype was far too advanced for its wings to be modified and this was the reason why an alternative pair had to be built, which were delivered in June 1936.

The first production Hurricane, L1547, flew on 12th October 1937 and the aircraft proved to be a most versatile machine. There were many Merlin-powered variants including a low-level attack version with two 40mm Vickers guns under the wings. The Hurricane also had the distinction of being the first monoplane fighter in the RAF and the first of the new types developed under the early expansion programme to be delivered to the service. Over 14,500 were eventually built and there were proposals to fit an example with the more powerful Rolls-Royce Griffon. A prototype was begun but never completed and on 27th February 1941 Roderic Hill, DGRD, reported that 'the Hurricane with Griffon is not considered worthwhile'.

Supermarine Type 300 Spitfire

The Chief Designer at Supermarine, Reginald Mitchell, acquired a great deal of experience of high-speed flight from his series of racing seaplanes built for the Schneider Trophy competition in the 1920s and early 1930s. His first real essay into fighter design was a machine called the Type 224 which was designed to a key specification of the early 1930s called F.7/30. The 224 had an inverted gull wing and a Rolls-Royce Goshawk engine but did not get airborne until 19th February 1934 (on 20th December 1933 Supermarine asked the Air Ministry's H Grinstead to reserve the name Spitfire for this aircraft). Due to the long delays the company was denied a production order but by the time the machine was delivered to A&AEE Martlesham Heath, Mitchell was discussing a number of drastic changes with the Air Ministry to increase its performance.

The arrival of the new Rolls-Royce PV.12 allowed Mitchell to move on to a new layout. In a letter to Buchanan dated July 1934 he outlined a specification and drawings for a modified F.7/30 which incorporated new smaller area wings, a retractable chassis, new fuel tanks and airscrew, new tailplane and a combined oil tank and cooler under the engine. It was estimated that the modified aircraft could fly in early 1935 and would offer a speed of 265mph (426km/h). The Ministry fell in with Mitchell's proposals but Buchanan now pointed out the likely need to fit eight guns (rather than the project's four) and he recommended asking Supermarine to build a completely new prototype rather than modify the old one.

In December 1934 a contract was placed for a prototype to be delivered by October 1935, although a few days later it was decided to fit a PV.12 rather than retain the Goshawk thereby improving the performance still further (it was the Air Ministry who pressed Supermarine to use this engine). A new specification, F.37/34, was allocated to the project and the Mock-Up Conference was held on 26th April 1935, during which Mitchell was shown the new F.10/35 document. He expressed a desire to bring his aircraft (now called Type 300) into line with this specification and on 29th April notified the Air Ministry of the modifications that he could incorporate to affect this.

The new thin elliptical wings of the Type 300, which were its special feature, presented many problems to installing the guns but prototype K5054 made its maiden flight on 5th April 1936. A large production order was placed in June 1936 and the first machine was delivered in July 1938. The Spitfire was to be built in huge numbers (over 20,000 with another 2,500 Seafires [Chapter 10]) and right through the war its makers achieved a near constant and progressive series of modifications, regularly signposted by the introduction of new marks. There were changes in armament through the introduction of cannon, changes to the cockpit but, above all, a continuous improvement to the Rolls-Royce powerplant which included the introduction of the Griffon.

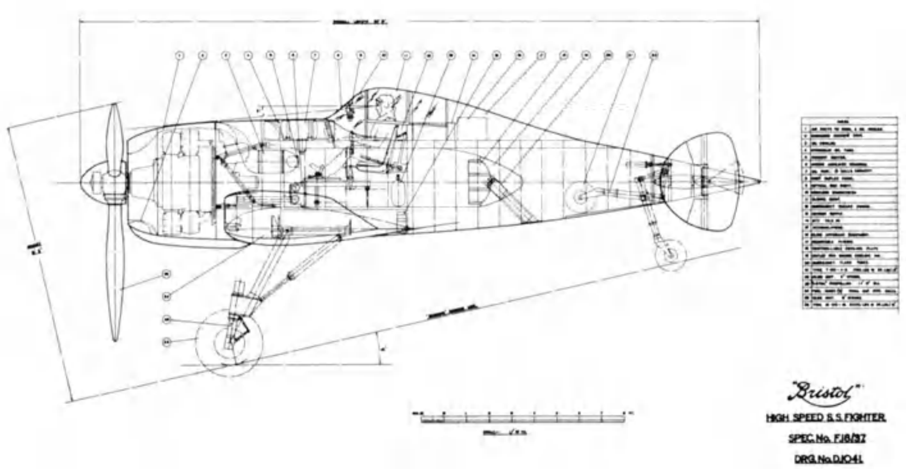
It was the need to keep a satisfactory margin of performance over enemy fighters that prompted the need to fit a Griffon, the first variant to reach production being the Mk.XII. However, Supermarine's first proposals for a Griffon Spitfire were actually made towards the end of 1939 and on 4th December a brochure was completed which suggested a

K
5054
K5054

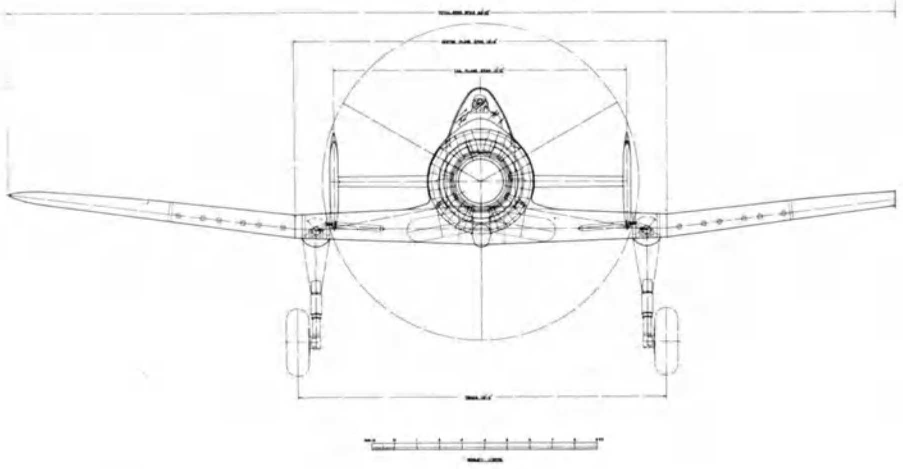
View of the Spitfire prototype K5054 with its twin-blade propeller.

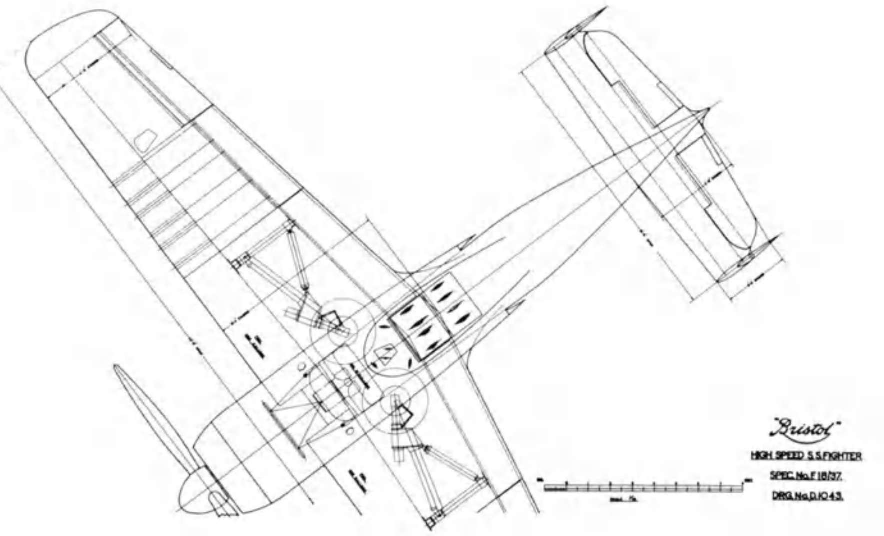
Spitfire X4942 was a Mk.I converted to Mk.VI standard, the first high-altitude development, and was photographed on 12.9.41.

Gorgeous view of a Griffon Spitfire Mk.24 banking towards the camera. Eric Morgan



Bristol F.18/37 with 'Centaurus' powerplant (2.5.38). Jim Oughton





top speed of 423mph (681km/h) at 18,500ft (5,639m), compared to 367mph (591km/h) for the standard Spitfire with the Merlin II. Difficulties with the development of the Griffon itself brought long delays to its service entry, the project often becoming rather static when each new version of the Merlin appeared. It was not until August 1942 that a decision was taken to proceed with production Spitfire fitted with the alternative engine. A proposed Griffon Spitfire F Mk.21 development with a reprofiled wing leading edge, the Type 372 or F Mk.23, was overtaken and pushed out by the 371 Spiteful described later. Perhaps the Griffon Spitfire really should have received a new name to reflect the great changes made to the original design, but any choice would have struggled to match the charisma of 'Spitfire'.

Specification F.18/37 Hawker Tornado and Typhoon

The description of the Spitfire, outlining as it does the gradual but constant development of the type throughout the war, offers a marked contrast to the method of fighter development adopted by Hawker during this period. In fact the philosophies of the two companies contrast and complement each other superbly. Reginald Mitchell tragically died in 1937 but he was replaced by Joe Smith who did a wonderful job keeping his fighter competitive. On the other hand Sydney Camm produced a series of all-new designs, Typhoon, Tempest and Fury, which were, however, closely related since each new design showed important similarities to its predecessor. Camm's hand was also forced by the lack of development potential in the Hurricane but the first of these follow-on aeroplanes, the Typhoon, actually resulted from a tender design competition.

Specification F.18/37, officially dated March 1938, called for a high-speed single-seat fighter to replace the Spitfire and Hurricane (for many years it was Air Staff practice to begin looking for a replacement almost immediately a new type entered service). A speed of at least 400mph (644km/h) at 15,000ft (4,572m) was requested, armament was increased to twelve 0.303in (7.7mm) Browning machine guns and service ceiling was not to be below 35,000ft (10,668m). The designs tendered to the specification are detailed below. (Note: although this chapter describes the RAF's single-engined fighters the need to put the F.18/37 tenders together means that some twin-engine jobs have to be considered here.)

Bristol F.18/37

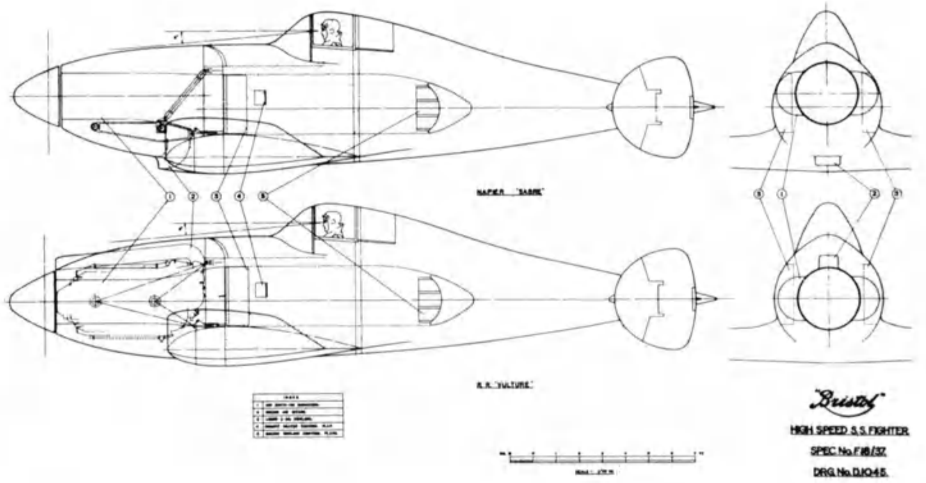
One basic design was proposed by Bristol which had three alternative engines, Bristol 'Centaurus', Napier Sabre or Rolls-Royce Vulture. No performance data survives but six machine guns were mounted in each wing outside the main wheels while a 100gal (455lit) fuel tank was housed in each inner wing. All versions had a span of 42ft 0in (12.8m) while the respective lengths were 30ft 0in (9.1m), 30ft 4in (9.2m) and 30ft 8in (9.3m).

Gloster F.18/37

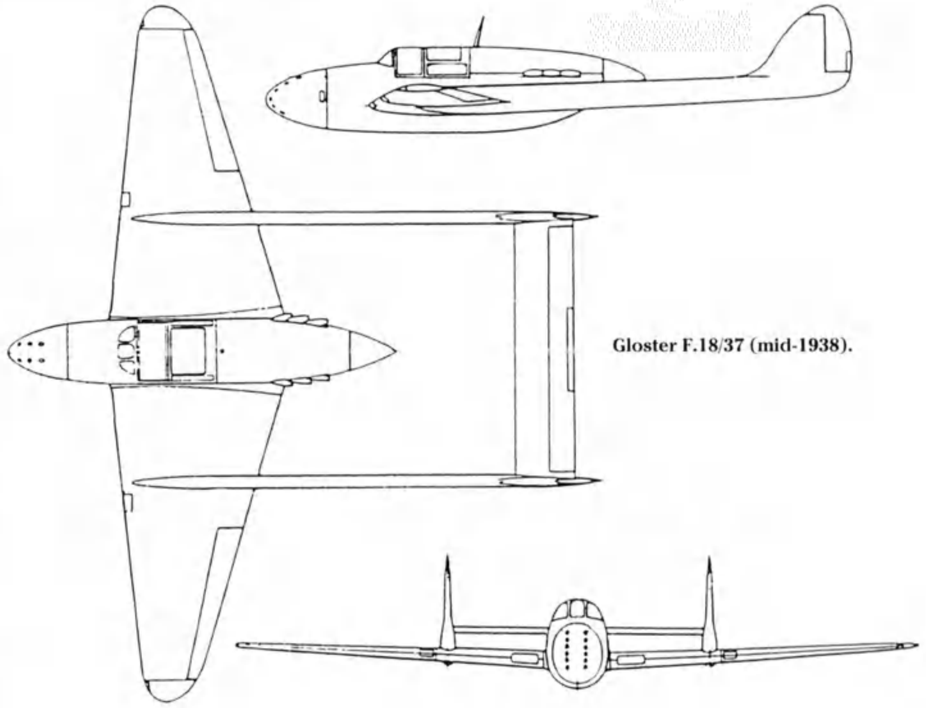
This company designed at least two twin-boom projects and another twin-engine layout to F.18/37, but the one to feature most in the Gloster archives had twin booms and was powered by a single Napier Sabre pusher engine served by radiators placed in the wing leading edge. This aircraft had twelve 0.303in Browning machine guns housed in the nose, mounted in pairs side by side on a central support, and a tricycle undercarriage. Service ceiling was 38,000ft (11,582m) and the aircraft was expected to take 4.1 minutes to reach 15,000ft (4,572m). It is believed that this project progressed to the mock-up stage.

An alternative twin-boom layout, quite similar to the first design, featured cooling radiators positioned in the front of the tail booms while the nose-mounted machine guns were replaced by a battery of five 20mm Hispano cannon. One assumes that this was a redesign brought about by the desire to fit cannon (described later), but when all of the cannon-armed F.18/37 projects were assessed by the Air Ministry later in the year, the Gloster pusher was not included because it was felt to be 'highly experimental'.

The third project was a more conventional twin-engined design based on the company's F.9/37 fighter (Chapter 2); in fact the wings, engine nacelles, 1,050hp (783kW) Bristol Taurus engines, tail and undercarriage employed on the Taurus-powered F.9/37 were carried over into this proposal. They were married with a new deep fuselage based on the twin-boomer's design with twelve Brownings in the nose. Data is lacking for this and the twin-boom cannon project but drawings for all three Gloster designs can be found in *Interceptor* by James Goulding. In the event Gloster was to build the great majority of the winning F.18/37 project, the Hawker Typhoon.

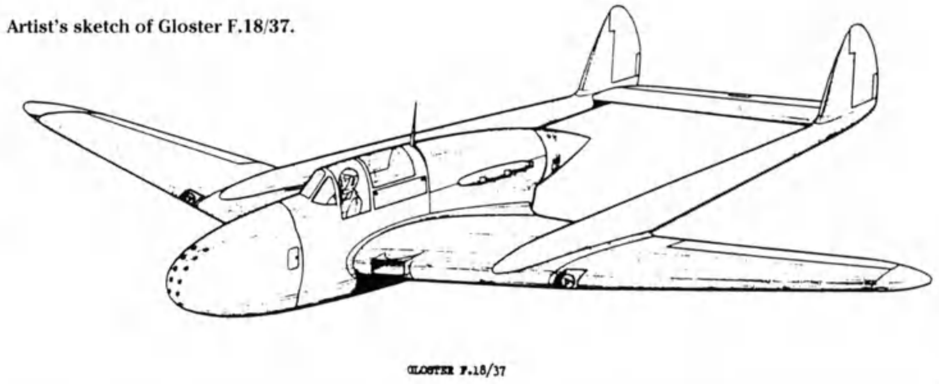


Top: **Side views of the Bristol F.18/37 with Sabre and Vulture engines (2.5.38).** Duncan Greenman Bristol AiR*chive*



Gloster F.18/37 (mid-1938).

Artist's sketch of Gloster F.18/37.



Hawker F.18/37

On 12th March 1937 Sydney Camm wrote to the Ministry's Director of Technical Development (DTD), Air Commodore R H Verney, to ask what he considered to be the most suitable new project on which his design staff should now concentrate; the reply included a new specification programme that mentioned a dive bomber at the top of the list and a single-seat fighter next. On 5th April design work commenced on a high-speed single-seat fighter fitted with a Napier Sabre and twelve Browning machine guns. Span was 40ft (12.1m), fuel capacity 200gal (909lit) and consideration was also given to fitting the Rolls-Royce Vulture engine.

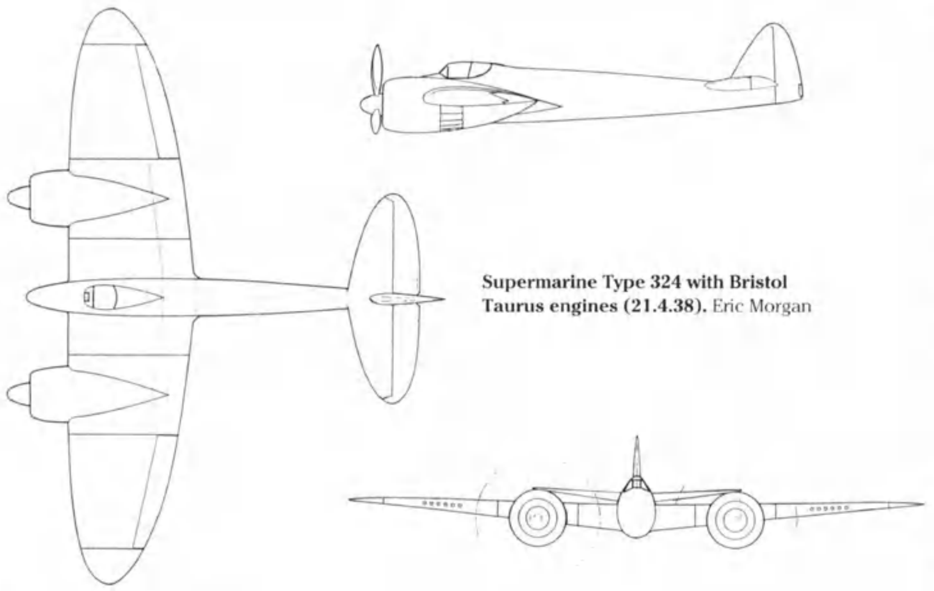
Drawings and data for the Sabre fighter were sent to the Ministry on 16th July and Verney replied on 27th August noting that the project had been carefully considered but 'in view of the fact that the Air Staff are about to issue the requirements for a new type of fighter on the same lines as the one you propose, I think it best to defer any action on your design as you will no doubt submit it again under the new specification [F.18/37], with any alteration you may think necessary. Generally speaking we like the design very much but are doubtful if the construction would provide the stiffness necessary for the speed without a fully stressed-skin wing'. In October Hawker began layout drawings for what it called the 'R' type fighter (Vulture engine), while on the 5th mock-up drawings of the 'N' type fighter (Napier Sabre) were issued to the Experimental Shop.

Part of the new specification arrived at Hawker on 14th January 1938 after Camm had made repeated requests to the Air Ministry that it might be issued 'without further delay'. However, the full document was not received until 4th April, together with an invitation to tender; later that month construction of a 'R' type mock-up began and the tender for both fighters was despatched on 30th April.

Supermarine 324

Various alternative arrangements were investigated by Supermarine to fulfil F.18/37 and two versions of essentially the same project, each with alternative engines, were described in brochures completed in April 1938. The company judged that twin-engined aeroplanes offered the best performance while actually giving a smaller machine than a single-engined type. The slightly increased complication from the duplication of engine controls and mountings was, in Supermarine's opinion, more than compensated for by the advantages which included opposite-rotating airscrews to prevent swing when taking off in formation, greatly improved pilot's view and a tricycle chassis for easier landing. Supermarine concluded that the twin was a much more efficient fighting aeroplane costing very little more to build or maintain.

The 324 was a tractor type; the alternative 325 described below had pusher engines. Their compact arrangement, made possible largely by the use of Fowler flaps and the tricycle chassis, gave a wing area only 20% greater than the Spitfire and a fuselage of the same length. The Fowler flap offered at least 10% more maximum lift over any other type while the undercarriage (supported by long-travel oleos of 10in [25.4cm] stroke) allowed the aircraft to be flown to the ground, without float, and gave freedom from the danger of ground looping.


Supermarine Type 324 with Bristol Taurus engines (21.4.38). Eric Morgan

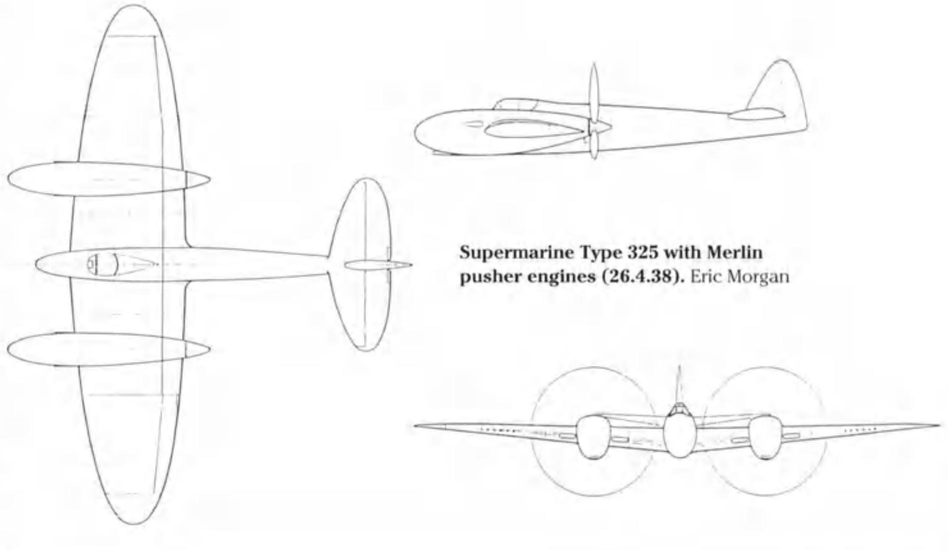
A monocoque fuselage and single-spar metal-covered wing, developed by Supermarine over several years, were both well tried and efficient methods of construction which the company felt was well suited to high speeds. The use of smooth flush riveted Alclad sheet enabled a perfectly smooth skin surface to be achieved which would give good aerodynamic efficiency while careful attention had also been given to simplifying the methods of construction, the latter making full use of experience gained on the Spitfire and B.12/36 bomber (Chapter 6). An example in this direction was a reduction in the number of rivets, in certain cases to a third of the number previously thought necessary.

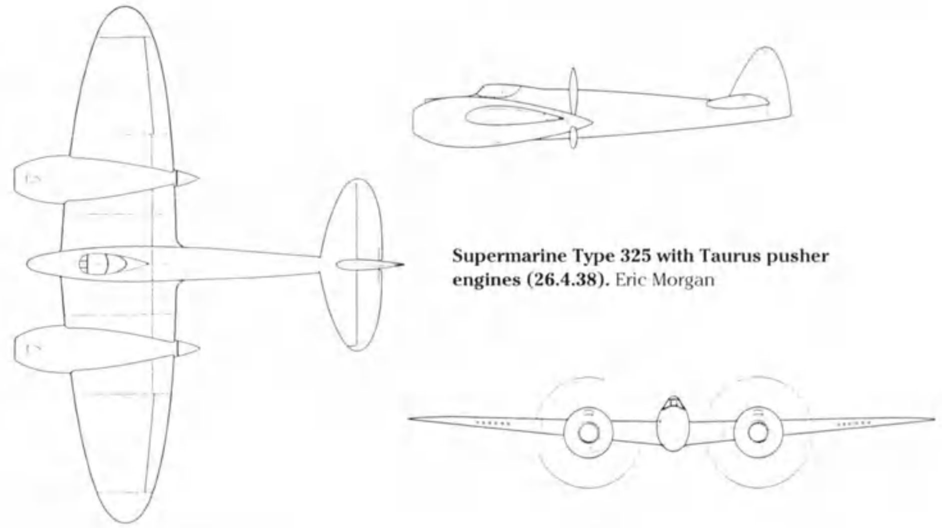
The wing followed the lines of the Supermarine F.7/30 and Spitfire fighters and was built of light alloy, chiefly Alclad which formed the entire covering except for the control surfaces. A single spar was provided at the maximum depth of the wing and two very robust fuel tanks, made in thick gauge light alloy, were incorporated in the wing nose forward of the spar. Although detachable, these tanks formed part of the structure and contributed to the structural strength and stiffness and, as fuel containers, gave very little weight penalty. Further, the weight of fuel relieved the bending loads during flight. A third tank formed the top portion of the fuselage aft of the main spar and fuel capacity was 163gal (741lit) for the Merlin, 169gal (768lit) for the Taurus. The radiators, main undercarriage and guns were all housed in the wing and no fabric was used except on the control surfaces. The Fowler flaps, enabling the wing area to be increased for landing and take-off, were of such proportions that they could be supported at the engine nacelle and fuselage only, without external drag-producing supports or complicated linkages.

The guns, twelve 0.303in (7.7mm) Brownings, were grouped in units of six in each wing which, complete with ammunition, could be quickly removed to allow swift reloading. For this purpose the wing aft of the spar and the torsion box in the way of the guns were hinged on both upper and lower surfaces. The fuselage was a shell structure of Alclad sheet into which was built a short wing centre section while the tailplane was of similar construction to the mainplane with a single spar and Alclad covering. Trimming was by tab and the elevator had a small horn, mainly to hold the mass balance weight, the aerodynamic balance being part inset and part by tab. A single fin was built into the fuselage rear and the rudder balance and trimming arrangements repeated that for the elevator. All of the fin and the tail were Alclad covered except the rudder and elevator which used fabric on light alloy spars and ribs.

This aeroplane could use an alternative Bristol Taurus radial engine installation rather than its Merlins. The provision of joints in the wing on each side of the engine nacelle enabled the water-cooled nacelle, complete with the portion of the wing containing the radiators, to be removed and the air-cooled unit, with cooling ducts, to be substituted. The balance was not appreciably affected by the change of engine and the Taurus reduced weight. To cool the Merlins, two interchangeable radiators were provided in each wing with leading edge intakes and trailing-edge outlets, which Supermarine felt gave less drag than any other system known at the time. For the Taurus, short ducts, as used on the B.12/36 bomber, were fitted in the nacelle.

The pilot was seated near the fuselage nose and had an exceptionally good field of view; in addition he could see the wingtips and so judge the aircraft's span when this was needed during taxying or formation flying. With two 1,145bhp (854kW) Merlins, sea level rate of climb was estimated to be 4,900ft/min (1,494m/min) and service ceiling 42,000ft (12,802m); the alternative 1,265bhp (943kW) Taurus units gave equivalent figures of 3,800ft/min (1,158m/min) and 37,900ft (11,552m).


Supermarine Type 325 with Merlin pusher engines (26.4.38). Eric Morgan


Supermarine Type 325 with Taurus pusher engines (26.4.38). Eric Morgan

Supermarine 325

This sister project was essentially the same fighter with the same features, although here the Merlin or Taurus power units acted as pusher engines. After investigation and consultation with Rolls-Royce, who had considerable experience of the transmission of aero engine power by shaft drive, it was decided that a pusher arrangement with an extended shaft to the airscrew was quite practicable for this design. The arrangement resulted in much less drag from the wing (which was removed from the slipstream) and increased the efficiency of the airscrews, and consequently the estimated maximum speed was 8mph (13km/h) higher. To give the pilot the best chance of escaping by parachute in an emergency a special brake was provided on each airscrew shaft which was capable of stopping the airscrew in about ten seconds.

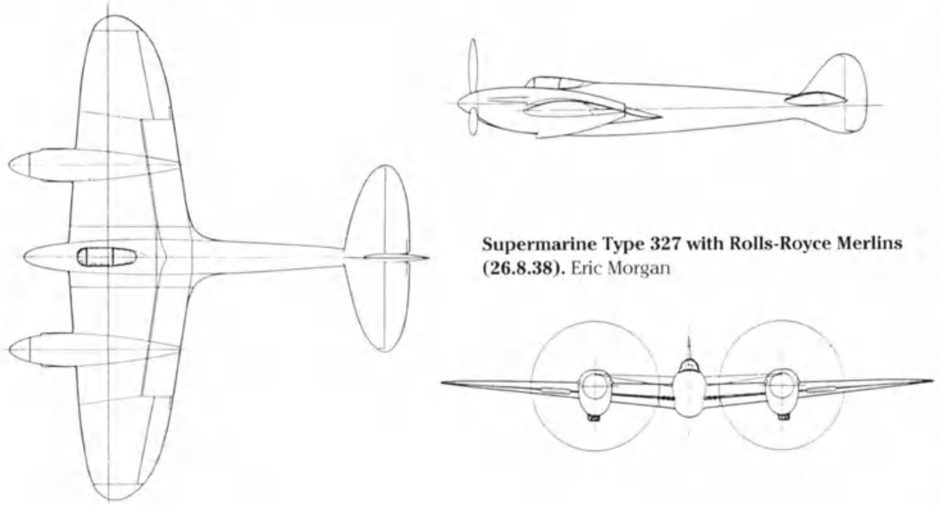
As before, the engine mountings were braced tubular structures built off the main spar and to the rear of the spar the nacelles were made of a shell structure that contained strong bulkheads to support the main chassis hinge. Housed at the tail of the nacelle was a rear bearing for the airscrew shaft together with the brake for stopping the airscrews in preparation for a parachute departure. Sea level rate of climb with two Merlins would be 4,950ft/min (1,509m/min) and service ceiling 43,500ft (13,259m); the alternative Taurus powerplant gave figures of 3,850ft/min (1,173m/min) and 38,500ft (11,735m). Fuel capacity was 158gal (718lit) for Merlin, 168gal (764lit) for Taurus.

* * *

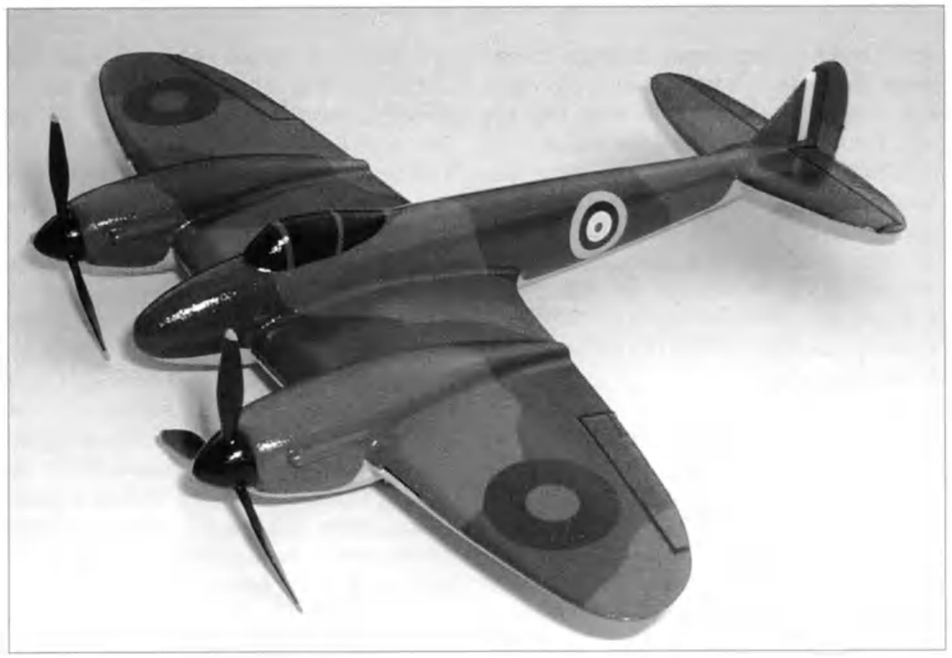
The designs selected for construction and flight test were the Sabre and Vulture-engined proposals from Hawker. By 30th August 1938 two prototypes of each had been ordered and the Mock-Up Conference for both was held at Kingston on 16th December. The Vulture flight test engine arrived on 23rd December but delays with the Sabre meant that a flight test engine was not delivered until 30th December 1939. On 10th July 1939 the Air Ministry placed an order for 500 Vulture and 500 Sabre F.18/37s and in August the 'R' type Vulture version was officially named Tornado. Prototype P5219 made its first flight on the 6th October while, in December, the 'N' type was officially named Typhoon. Typhoon prototype P5212 made its maiden flight on 24th February 1940 and the second Tornado, P5224, flew on 5th December 1940 with the engine radiator moved to the forward position, local flow reversals having occurred around the rear part of the original ventral arrangement. An Air Staff memo dated 4th January 1939 noted that the 'Vulture is ahead of the Sabre, but the Sabre does promise advantages in horsepower, a better shape and therefore a better engine, and therefore a better aeroplane', and it recommended continuing with the Sabre installation.

Left: **Hawker Tornado prototype P5219 with its original ventral radiator.**

Bottom: **Model of the Supermarine 327.** Joe Cherrie



Supermarine Type 327 with Rolls-Royce Merlins (26.8.38). Eric Morgan



In the event, thanks to problems with the Vulture's design, the Tornado-Vulture programme was stopped on 15th October 1941, although a prototype was later flown with a 2,500hp (1,864kW) Bristol Centaurus 5 radial engine. This latter project was first discussed in January 1940 but a contract to convert one prototype was not placed until 22nd February 1941. In October 1941 the Ministry renamed the project the 'Centaurus-Typhoon' (because the Tornado had been dropped) but this was not agreed to by Hawker because its fuselage was similar to the Tornado. The prototype, HG641, made its first flight on 23rd October 1941 and later achieved a top speed of 402mph (647km/h) at 18,000ft (5,486m). In early 1942 converting the Typhoon to take the Centaurus became an urgent requirement and plans made in June to fit the engine to the Typhoon II (Tempest) were given the highest priority. It was intended that, prior to the Sabre (which was suffering many teething problems), production Typhoons would use Centaurus but none of the later Centaurus proposals ever became hardware.

The first Typhoon prototype was armed with twelve Browning machine guns but when the second, P5216, became airborne on 3rd May 1941 it carried four cannon. In mid-1938 consideration was given to fitting cannon instead of machine guns into the F.18/37s, although work was also ongoing on the Westland F.37/35 (Whirlwind) cannon-armed fighter (Chapter 2). However, the Air Staff noted that progress on the Westland, and Boulton Paul's F.11/37 twin-engined P.92 turret fighter (Chapter 3), had been slow, possibly because neither company had any competition to fear, and as a result the F.18/37 tenders were revised to carry cannon. Supermarine therefore tendered a new brochure in August 1938 after having abandoned its pusher designs.

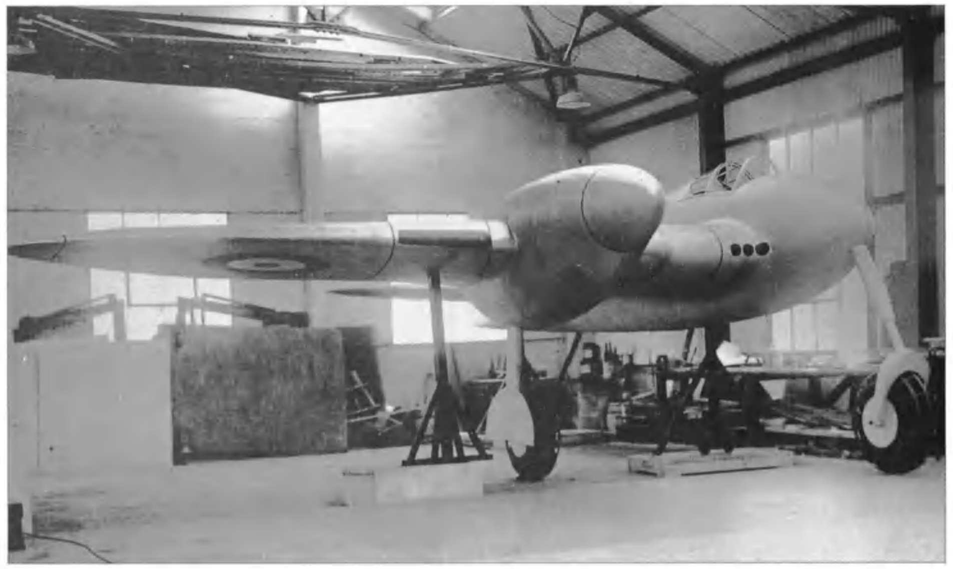
Supermarine 327

The main change from the earlier projects was the fitting of three 20mm cannon in each of the wing roots instead of the six machine guns in each outer wing, although by fitting alternative outer wings the Brownings could replace the cannon for ground strafing if so desired. The primary powerplant was the Merlin, but the Taurus was still an option, and the structure was essentially unchanged although the pilot was now protected by armour. Service ceiling was calculated to be 40,000ft (12,192m) with the Merlins and 35,500ft (10,820m) with Taurus, rate of climb 4,550ft/min (1,387m/min) and 3,450ft/min (1,052m/min). The Merlin's fuel capacity was 170gal (773lit) and a mock-up of the 327 was built.

Previously, on 29th July, W Sholto Douglas, the Assistant Chief of the Air Staff (ACAS), had noted that 'the Ministry had no interest in machine gun fighters but was anxious to see the development of fighters capable of carrying 20mm Hispanos. Sir Robert McClean [of Vickers] made the point in his covering letter that Supermarine had great experience of high-speed work culminating in the Spitfire'. However, after assessing the project, R N Liptrot wrote on 16th September that 'McClean was naive when he presents a rehash of an earlier tender design as a new conception already considered and found unacceptable. I see no reason for recommending action [on the 327].'

However, on 24th November an Air Staff meeting chaired by Air Commodore Roderic Hill, the new DTD, discussed the project. H Grinstead began by saying that the possible adoption of the 327 was one of policy – there was an urgent need for a 20mm gun fighter and the question was whether the need was so urgent that they should 'plunge' on Supermarine's revised design, when the earlier machine gun versions had been turned down in favour of Hawker's proposals because they showed very little advantage over the latter's single-engined layout. Supermarine had pushed for the cannon 327 because Westland's F.37/35 was the only cannon fighter in view and contained a number of experimental features and so a back-up was required.

There was at this time a further proposal to redesign the Bristol Beaufort bomber with four 20mm guns (a project which became the Beaufighter [Chapter 2]), while the Gloster F.9/37 twin-engined fighter (also Chapter 2) had recently been converted into a fixed-gun fighter by deleting a requirement for a four 0.303in (7.7mm) dorsal turret. The latter was to receive forward-firing guns only while the Boulton Paul P.92 was considered to be a long development job. Grinstead felt that Supermarine was usually slow in producing a prototype and, judging from the Spitfire, in production also. W S Farren could see no advantage in the 327 that was not offered by the Gloster F.9/37 while Major H S V Thompson reported that his department (R D Arm) was not impressed with the 327's gun layout; the feed arrangements were thought to be impracticable and there did not appear to be room for three guns in each wing.



Above: **Supermarine Type 327 mock-up complete with tricycle undercarriage.** Eric Morgan

Below: **Spectacular view of Hawker Typhoon Mk.1B JR128 which show the four wing-mounted cannon well.** Barry Guess, BAE Systems, Farnborough

The advantages of the 327 were a superior performance over the Bristol, Gloster and Westland designs and its tricycle undercarriage. However, the Air Staff felt that the nearest projects for a cannon fighter were the redesigned Beaufort and the Westland F.37/35 and the general consensus of the meeting appeared to be that it could not recommend expending energy in developing the 327, but would rather concentrate on the three twin-engined designs already in hand. There was also the desirability of avoiding a multiplicity of types and the meeting recommended that the 327 should not be taken up.

In due course, as noted already, the Hawker Typhoon was adapted to take cannon. In fact the first modification was proposed in August 1938 and by mid-December of that year discussions between Camm and the Ministry were well advanced. The Typhoon entered service in September 1941 and over 3,300 were built. In the event, thanks to a poor rate of climb and altitude performance, it did not prove particularly successful as an interceptor fighter but, with four wing-mounted cannon, it became one of the best ground attack aircraft used by any nation during the war.

Hawker Tempest

Sydney Camm quickly turned his attention to improving the Typhoon and a redesign was treated virtually as a new type under project number P.1012; it was called the Typhoon II. The first Typhoon II discussions took place on 24th April 1941 when DTD, now N E Rowe, visited Sydney Camm at Claremont and the development embraced a Sabre E.107C engine (later the Sabre IV), four-blade propeller, six cannon wings, extended wingtips to increase span and a cleaned up tail. Compared to the original Typhoon I the new project had completely redesigned thinner wings of elliptical planform and improved profile, a 42ft (12.8m) span and a wing area of 300ft^2 (27.9m^2). The engine was moved forward relative to the wing which made room for more fuel in the body in front of the pilot, the nose radiator was deleted and replaced by wing radiators but the rear fuselage was unchanged. Hawker sent a performance summary and general arrangement drawing to the Ministry of Aircraft Production (MAP) on 9th September 1941. The elliptical wing had first been investigated in 1940 but delayed by the demand for Hurricanes.

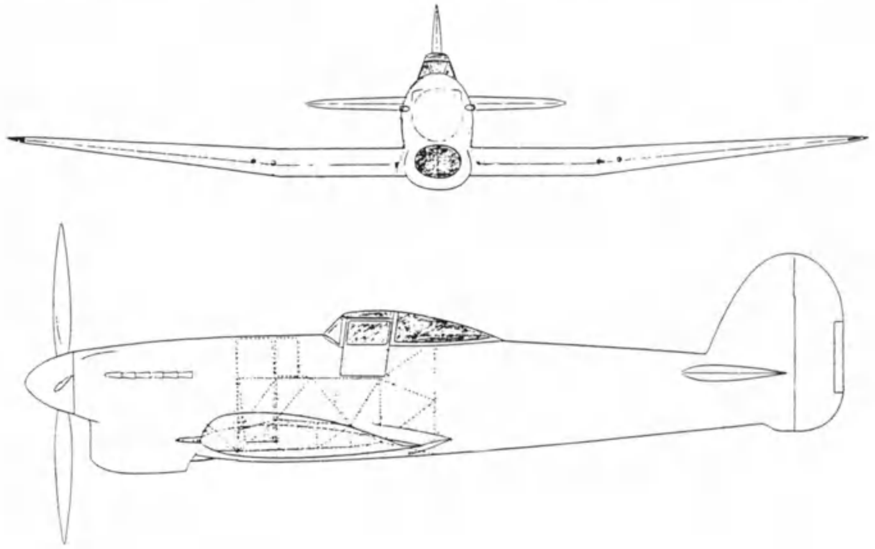
At a weight of 11,300lbs (5,126kg) the Sabre IV offered 455mph (732km/h) at 26,000ft (7,925m) and a ceiling of 35,300ft (10,759m). Rowe liked the fighter and on 17th September Camm was notified of a decision to convert two Typhoons to the new design; a formal contract for two prototypes followed on 18th November. Specification F.10/41 was written to cover the aircraft and it was recognised very quickly this could be a fast aeroplane. In January 1942 Camm suggested to MAP that the modifications to the original Typhoon were so drastic that the Typhoon II should be renamed and on 6th August it was officially retitled Tempest. It was eventually decided that just the one prototype should be completed, parts for the second being held back in case of damage to the original.

Back in 1941 the halt to the Tornado production run had meant that the Centaurus programme henceforth became related to the Typhoon and on 15th October Camm was informed that a strong request should be expected for a 'Centaurus Typhoon'. Six prototypes of this version, what was to become the Tempest II, were ordered in February 1942, Rowe stating on the 3rd that the mark's development was a matter of urgency. The first prototype, LA602, first flew on 28th June 1943 and by 29th August had achieved a top speed of 461mph (742km/h) at 21,000ft (6,401m).

Some six months late, the original Tempest's first flight date was 2nd September 1942. The aircraft, HM595, was in fact fitted with a Sabre II and the standard Typhoon cooling system complete with chin radiator. Delays in developing the Sabre IV had slowed things down and prompted the decision to install this alternative but since the airframe had been prepared for the IV, considerable redesign was necessary and the radiator was moved back under the nose to avoid any compressibility problems. As a solution Rowe recommended more prototypes and the Aircraft Supply Council approved six on May 27. A formal contract was placed on June 17 for two prototypes fitted with Sabres, two with the Bristol Centaurus (down from six) and the last pair with Rolls-Royce Griffons. The Sabre IV prototype with wing leading edge radiators became the Tempest I while HM595 with the Sabre II was called the Tempest V prototype. The Centaurus version became the Tempest II and the Griffon-powered aircraft the III and IV.

A lovely series of air-to-air photographs was taken of the Tempest I during a test flight. The author considers that, with the later bubble canopy fitted, this aircraft was very attractive. BAE Systems

Hawker Tempest Mk.II MW736.



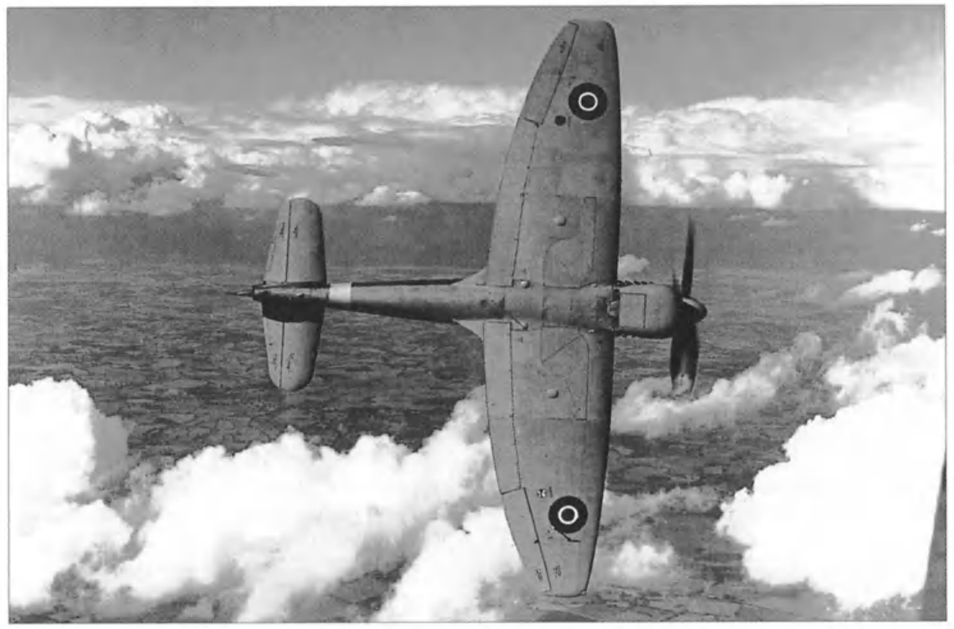
Partial general arrangement of the Hawker P.1016, the Tempest III with modified nose to accommodate a Rolls-Royce Griffon (2.4.42). Note the smaller radiator compared to the Sabre-powered Mk.V.

Work on the Tempest I, the old second prototype, restarted when the Sabre II was fitted to HM595. It was serialled HM599 and first flew on 24th February 1943; the wing radiators became a source of much discussion. In August 1942 Hawker had proposed to change over to leading edge radiators on the Tempest I after the first few aircraft to cut drag and give better protection to the radiator from fire from the rear, but problems with their manufacture caused delay and the final radiator arrangement chosen for the Tempest was affected by the production situation. As late as 12th November 1942 Camm told the Ministry 'if the Tempest is delayed we may have time to develop the leading edge position, which is probably the best arrangement.'

The Tempest III and IV were never built. The Griffon version was begun as the P.1016 and a drawing showing a Tempest V with the nose altered was attached to a letter from Camm to Rowe dated 10th April 1942. Camm explained that Hawker had for some time been considering an alternative engine for the Tempest and he felt this combination was a good one, particularly since they could use a Griffon 61 when it arrived without structural changes. The Griffon was lighter than the Sabre but slightly longer which left the balance of the aircraft practically unchanged. Camm felt this project had great possibilities and made the firm feel altogether happier about the Tempest. The Tempest III with the Griffon IIB and Tempest IV with the Griffon 61 carried 140gal (637lit) and 145gal (659lit) of fuel respectively and offered times to 20,000ft (6,096m) of 9.0 and 8.3 minutes while their ceilings were 31,500ft and 40,000ft (9,601m and 12,192m). The Air Ministry became interested and when Rowe visited Kingston on 6th May he requested that work should begin as soon as possible on a Griffon 61 prototype.

The Controller of Research and Development (CRD), Air Marshal F J Linnell, felt the aeroplane had a worthwhile performance with the Griffon 61 but was not acceptable with the IIB, although that showed a marked improvement over the Hurricane; it was, however, heavier than an aeroplane specifically designed for the 61. The real merit of the proposal was that it could provide a replacement for the Hurricane and was capable of being produced in the large numbers that this would imply. He felt that the aeroplane could easily be made to carry 'the paraphernalia for low attack work' and the narrower engine automatically improved the view for low level flying.

R S Sorley made reference to the time element where Tempest production would not start until mid-1943, when large numbers of



Two views of a Hawker Tempest V, the first mark of Tempest to fly. Barry Guess, BAE Systems, Farnborough

Typhoons would be on the line. The introduction of the Griffon Tempest had to come but the Typhoon was regarded as the first step in a conversion from the Hurricane in the low attack role; in the event the Typhoon fitted that role perfectly and the Tempest III was never built. The two Tempest III prototypes were to be serialled LA610 and LA614 and the former eventually flew as a Griffon Fury prototype; the latter was cancelled. (There had also been plans for a Griffon Typhoon I which dragged on for quite a while, but these were dropped when it was realised that the effort would be better spent on a new aircraft.)

The Tempest immediately demonstrated far superior performance, rolling and handling over the Typhoon while HM599's early flights revealed even better directional stability than the Tempest V and it was unbeatable in the dive or zoom climb. The maximum true airspeed achieved by HM599 appears to have been 472mph (759km/h), well above the original estimate. It remains one of the fastest piston fighters ever to have flown.

The initial plans made in February 1942 called for 100 Tempest Is and a contract was placed on the 24th; five days later the figure was increased to 400. The Mk.I Tempest was intended to be the production version, the chin radiator Mk.V remaining a test bed, but eventually the latter was chosen for manufacture. Another 700 Mk.V and I aircraft were ordered on 12th February 1944, but this was amended two months later to 1,300 Tempest V and 300 Tempest I. The 300 Mk.Is were changed in May to Mk.VI aircraft with chin radiators and any chance for production of the wing radiator Mk.I finally disappeared. The Tempest VI was really a Mk.V fitted with a Sabre V and the original Tempest, HM595, was the first to receive it, flying on 9th May 1944. In June 1943 a comparison of level speeds was completed between the Mks.I and V and the increase in speed using the wing leading edge radiators was found to be between 7mph and 10mph (11km/h and 16km/h) in FS Gear, but not measurable in MS Gear.

The cause of abandoning the Tempest I, as given by the official historian at MAP, was that by December 1942 the Sabre IV had failed type testing three times and when reviewed by the Ministry was expected to be an unreliable engine. As a result, large-scale production was dropped. However, the staff at Langley understood that the wing leading edge radiators were unpopular with the Air Ministry. Just the one Mk.I Tempest flew but 452 Mk.IIs (which served with the RAF post-war), 800 Mk.Vs and 142 Mk.VIs were completed.

Lovely air-to-air of Tempest Mk.II MW742.

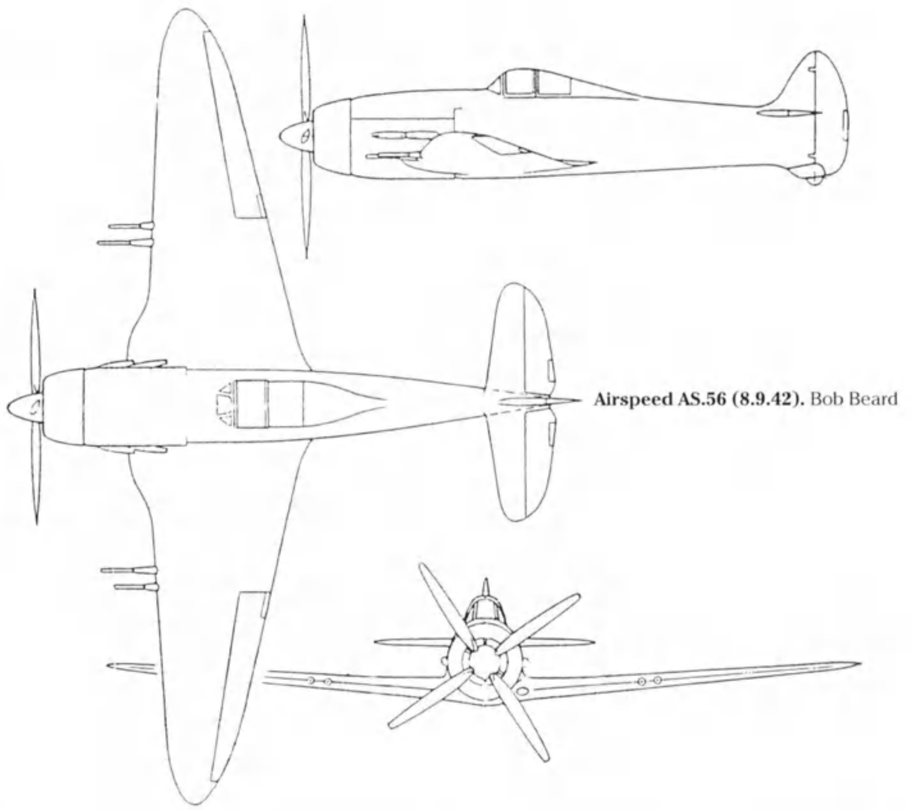
Specification F.6/42

By the middle of the war, aircraft such as the Typhoon had become rather large for a single-seat fighter. The Typhoon's successor, the Tempest had a thinner wing which offered improved aerodynamics but it was still larger and heavier than, for example, the Spitfire. To further increase performance it was felt that a light fighter was desirable and, to this aim, F.6/42 was raised in September 1942 which also called for a speed of 450mph (724km/h) at 20,000ft (6,096m), a sea level rate of climb of 4,500ft/min (1,372m/min) and four 20mm cannon. The type was intended to be a medium-altitude high-performance fighter and superior in climb, speed and manoeuvrability to any German fighter which might be developed from the Focke-Wulf Fw 190; the document stressed the importance of rolling manoeuvrability. Five prototypes and eight production aircraft were to be flying by December 1944 and nearly 4,000 by mid-1946, if the war was still ongoing.

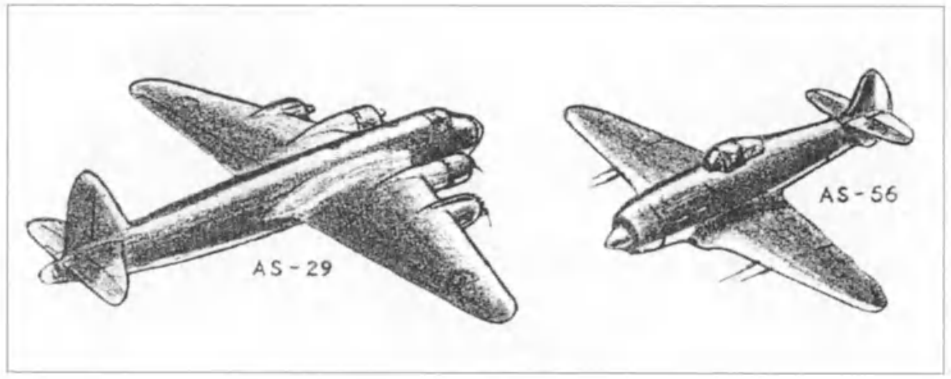
In August 1942 the outline requirements were sent to Boulton Paul, Hawker, Vickers-Armstrongs, Supermarine and Westland which prompted Camm to reply that 'the time is long overdue when intensive attention should be given to all weights other than the aircraft structure and the bare military load.' Meanwhile, during July and August 1942 discussions between Folland and Sir Roy Fedden of Bristol Engines led them to think that they could rapidly bring to fruition a new design of fighter. Airspeed also showed interest in the specification but Boulton Paul felt that it would not be possible to achieve the desired performance with the specified engines, the Griffon 61, Sabre NS.43.SM and Centaurus CE.12.SM. The first half of September saw designs tendered from seven companies; Folland's brochure and model was submitted on the 4th but a day later Bristol, who were expected to provide testing and laboratory facilities including wind tunnels, withdrew from working with Folland. The design proposals were as follows:

Airspeed AS.56

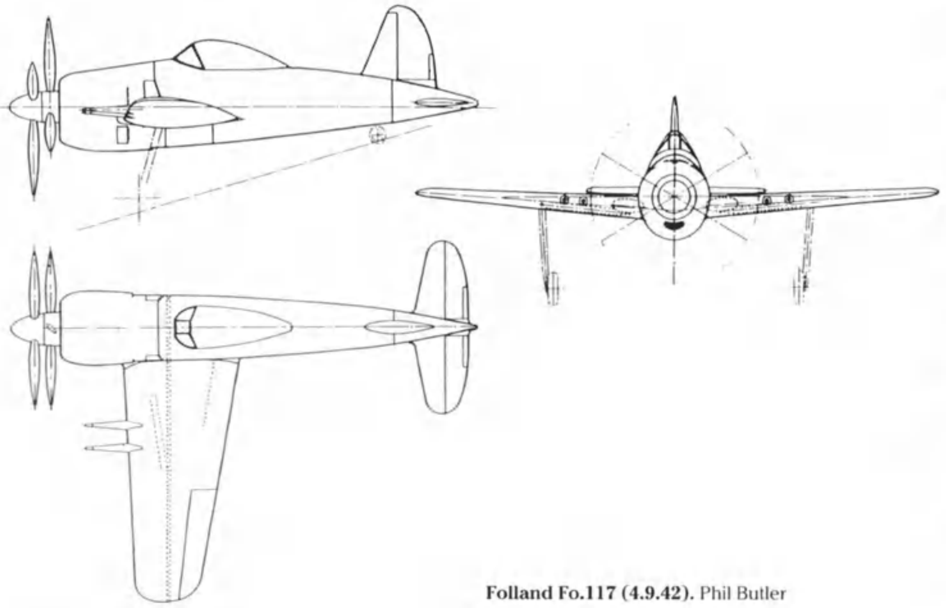
This used a Napier Sabre IV with a fan-cooled annular radiator in the nose to reduce drag. It had four 20mm cannon in the wings and the maximum rate of climb was estimated to be



Airspeed AS.56 (8.9.42). Bob Beard



Artist's impression of the AS.56. (and AS.29 bomber to B.1/35 – see page 94.)



Folland Fo.117 (4.9.42). Phil Butler

4,675ft/min (1,425m/min) at 6,500ft (1,981m) and 4,020ft/min (1,225m/min) at 18,600ft (5,669m). Design work on this project was quickly abandoned but work on the radiator arrangement was continued by Napier to try and solve the Sabre's overheating problems and this was test flown on both Hawker Typhoons and Tempests.

Boulton Paul P.98
This design featured a tail-first layout and either a Griffon or Sabre pusher engine driving contra-rotating propellers. The mean maximum rate of climb up to 20,000ft (6,096m) was 4,640ft/min (1,414m/min) for the Griffon and 4,900ft/min (1,494m/min) for the Sabre.

Folland Fo.117
This was the only design to feature a contra-rotating airscrew on a tractor engine (a 2,125hp [1,585kW] Centaurus XII). Estimated maximum rate of climb was 4,900ft/min (1,494m/min) at sea level, 5,080ft/min (1,548m/min) at 6,000ft (1,829m) and 3,600ft/min (1,097m/min) at 20,000ft (6,096m). Service ceiling was 39,500ft (12,040m) and four 20mm cannon were mounted in the wings. Folland claimed that this project could replace obsolete types still in production and the fighter was to be superior in climb, speed and manoeuvrability to any German fighter which might be developed from the Focke-Wulf Fw 190.

Hawker P.1018, P.1019 & P.1020
These were essentially the same aircraft but with Sabre 43, Griffon 61 and Centaurus IV power units respectively. The Sabre version would have a radiator in a duct in the rear fuselage and a much slimmer fuselage than the Typhoon. The shorter Centaurus variant would allow the pilot to be placed well forward with the fuel stored behind him close to the CofG; armour could then be put behind the tank, thus protecting both pilot and fuel at the same time and saving weight on tank protection. Estimated maximum rates of climb for the Griffon were 5,100ft/min (1,554m/min) at 7,000ft (2,134m) and 4,180ft/min (1,274m/min) at 19,500ft (5,944m); respective figures for the Sabre were 5,500ft/min (1,676m/min) and 4,200ft/min (1,280m/min) and for the Centaurus 5,700ft/min (1,737m/min) (at 6,500ft [1,981m]) and 4,000ft/min (1,219m/min).

Supermarine F.6/42
This was substantially the Spitfire Mk.XXI with a re-rated Griffon 61. Its maximum rate of climb was 5,040ft/min (1,536m/min) at 10,000ft (3,048m) and 4,400ft/min (1,341m/min) at 19,000ft (5,791m).

Vickers F.6/42
On 11th September Vickers-Armstrongs submitted a folder to F.6/42 but the available Ministry documents make little reference to it and no data (apart from a maximum weight of 9,500lb [4,309kg]), or a drawing, has been traced. However, Vickers did claim an 'excellent climb rate'.

Westland F.6/42
This had a Griffon 61 and a Gallay ('horse collar') radiator slung in a duct beneath the engine. Westland proposed air cooling instead of liquid cooling for the intercooler and claimed that this reduced the final weight by 85lb (39kg), while the Griffon was selected because its production position appeared to be better than the alternatives. Maximum rate of climb was expected to be 4,650ft/min (1,417m/min) at 6,500ft (1,981m) and 4,150ft/min (1,265m/min) at 19,600ft (5,974m); service ceiling 40,000ft (12,192m). This project was also developed as a naval fighter, possibly to N.7/43.

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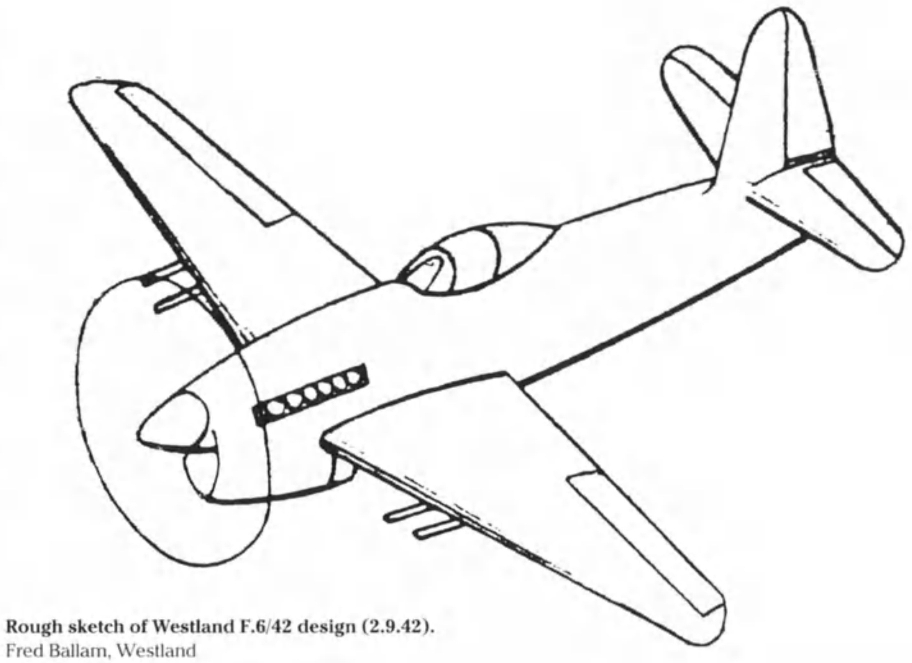
In mid-September MAP's Capt R N Liptrot completed a brief assessment of the contenders. He felt Westland's suggestions in regard to the power unit, and the cooling system proposed by Airspeed, were probably worth further investigation. Airscrew design was a compromise between top speed and climb; bigger diameters would give further improvements in rate of climb but only with serious losses in efficiency at top speed. Westland's rather big propeller diameter would give a rather high tip speed under top speed conditions which would introduce some uncertainty about the airscrew efficiency. Liptrot had spoken to Rolls-Royce about Westland's radiator proposals and was told that Rolls had already tried this arrangement and abandoned it because they considered that there was nothing to gain from it.

For Liptrot, the only real point of interest in the Folland Fo.117 was the use of small diameter contra-rotating airscrews while Boulton Paul's layout did not look attractive for a fighter. The AS.56's annular radiator was considered enterprising but necessitated an elongated airscrew shaft and fan drive which was hardly the sort of thing to contemplate if the F.6/42 was really required in service as quickly as possible. He felt Airspeed could not possibly substantiate the high top speed given in the brochure, which was postulated from an estimated 420hp (313kW) from ejector exhausts and a further 200hp (149kW) from 'alleged heat regeneration made possible by the proposed cooling system'.

RAE was also asked to appraise these designs and gave a rough order of merit – 1. Vickers-Armstrongs and Folland, 2. Hawker and Airspeed and 3. Supermarine and Westland, but noted that the Vickers project was completely lacking in detail and 'further detail might make it less satisfactory'. In due course RAE favoured the Fo.117. N E Rowe suggested that Folland would have difficulty designing the aircraft quickly enough and by 13th November Folland's experience and organisation at Cheltenham had been thoroughly investigated to assess its ability to carry the fighter through to production. The conclusion was that the company was not yet ready; however, Folland was prepared to work with another firm. Eventually Rowe contacted all of the companies except Folland and Hawker to say that their designs had been turned down. By 29th December, following several minor modifications, Folland had improved its performance figures and the all-up-weight was now 9,170lb (4,160kg). In February 1943 a new specification F.2/43 was allocated to the Hawker proposals to simplify the situation.

Support began to grow for Hawker's design but in some quarters it was seen as a 're-hashed Tempest' (the discussions relating to F.6/42, for Folland or Hawker, appear to have been very heated). Air Chief Marshal Sir Charles Portal, CAS, thought the Fo.117 was particularly good in control and manoeuvrability, especially in the rolling plane. Also the air-cooled engine was of considerable value to the Air Staff and he could not see how they could drop the type. Sir Wilfrid Freeman wrote to Portal on 19th December 1942 saying there was little to choose between the Fo.117 and the Tempest II, but Folland's was just an estimate of what might be achieved where the Tempest II estimates were based on a fair amount of established evidence with little doubt of attainment. The latter was also at an advanced stage of development when the Fo.117 was just an outline drawing with details and jigging still required. Freeman could not see the Folland in production before summer 1945. Six days later, on Christmas Day, Portal asked that the Fo.117 should be built but Freeman maintained his support of the Tempest II.



Rough sketch of Westland F.6/42 design (2.9.42).
Fred Ballam, Westland

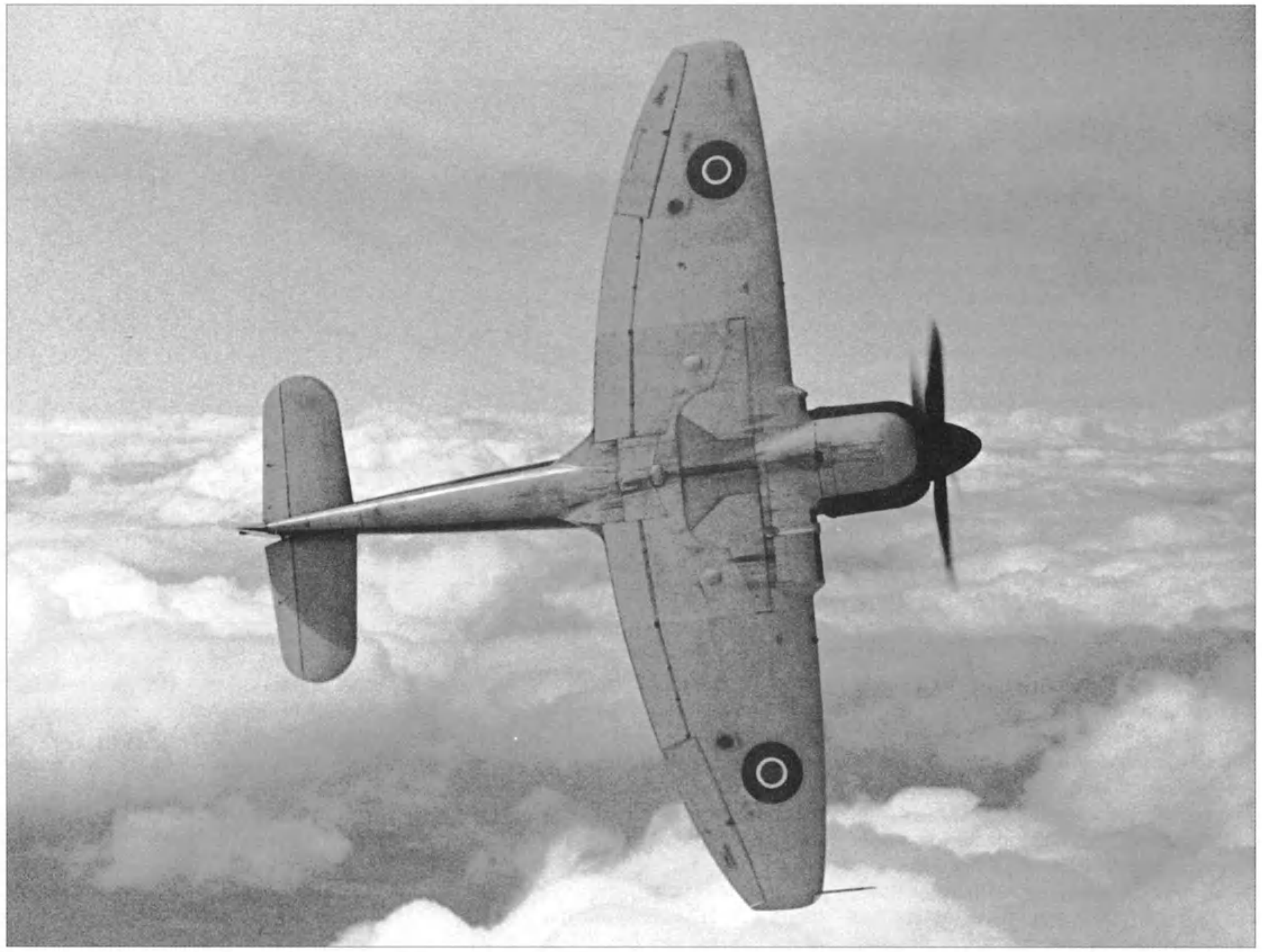
In March 1943 the decision was taken to drop the Fo.117, a move that made Portal particularly angry. On 25th March Air Marshal Linnell told Portal that he was still quite unconvinced as to the wisdom of starting Folland's design at this time. He felt that Folland was 'much too weak to undertake unaided the design and production of even prototypes in any reasonable time.' At this point, with very heavy civil aviation commitments as well as wartime work, the country's design capacity was absolutely overstretched and Linnell did not wish to 'squander even the slightest bit of it on a job which does not show an absolute clear advantage over anything else we have in hand.' Of the two projects, Folland and Hawker, he expected the latter months if not years earlier than the Folland prototype, so the Folland F.6/42 would not affect the war effort by the end of 1944. Had there not been the shortage in design capacity, Linnell would have agreed to letting Folland 'have a try', but at the moment he thought it was quite wrong to squander resources on the Fo.117.

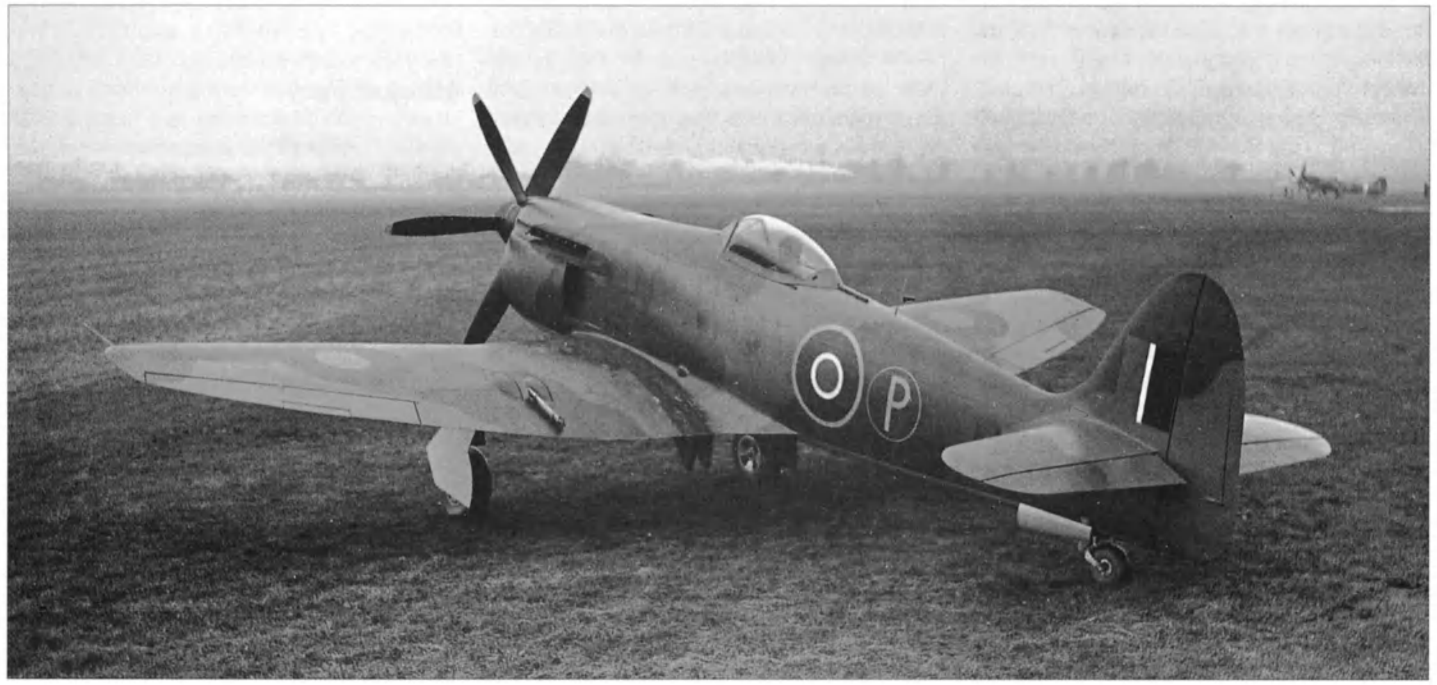
What probably killed the Fo.117, which seemed to offer a superior speed and rate of climb over its Hawker competitor, was that the data figures were estimates (experience had shown that these were often over-optimistic) while the Folland company was a relatively new and inexperienced player in fighter design. Folland was told to proceed with its E.28/40 naval project. Later in the year there was an attempt to revive the fighter as the Fo.117A with a laminar flow wing, a 2,500hp (1,864kW) Centaurus 12 and a contra-rotating propeller, with production to be undertaken by English Electric. Six prototypes were ordered on 10th September 1943 to Specification F.19/43 but they were never built.

Hawker Fury

On 3rd February 1943 a meeting attended by Linnell, ACAS, Rowe, plus Frank Spriggs and Sydney Camm of Hawker, was held at I C House. The Tempest II programme had slipped badly and a decision was needed regarding whether to cut out the II and go full out for the F.2/43. In the event it was decided that both Tempest I and Tempest II programmes should continue; the F.2/43 was, however, to be pursued with all speed.

Thanks to Camm's excellent track record with the Hurricane, Typhoon and Tempest, the 'Improved Tempest' or 'Tempest Light Fighter' received strong support. The earliest discussions had centred on lightening the Tempest and included a one-piece wing using Tempest wings brought together on the centre line of the aircraft to reduce the span. Figures suggested a drop in structure weight

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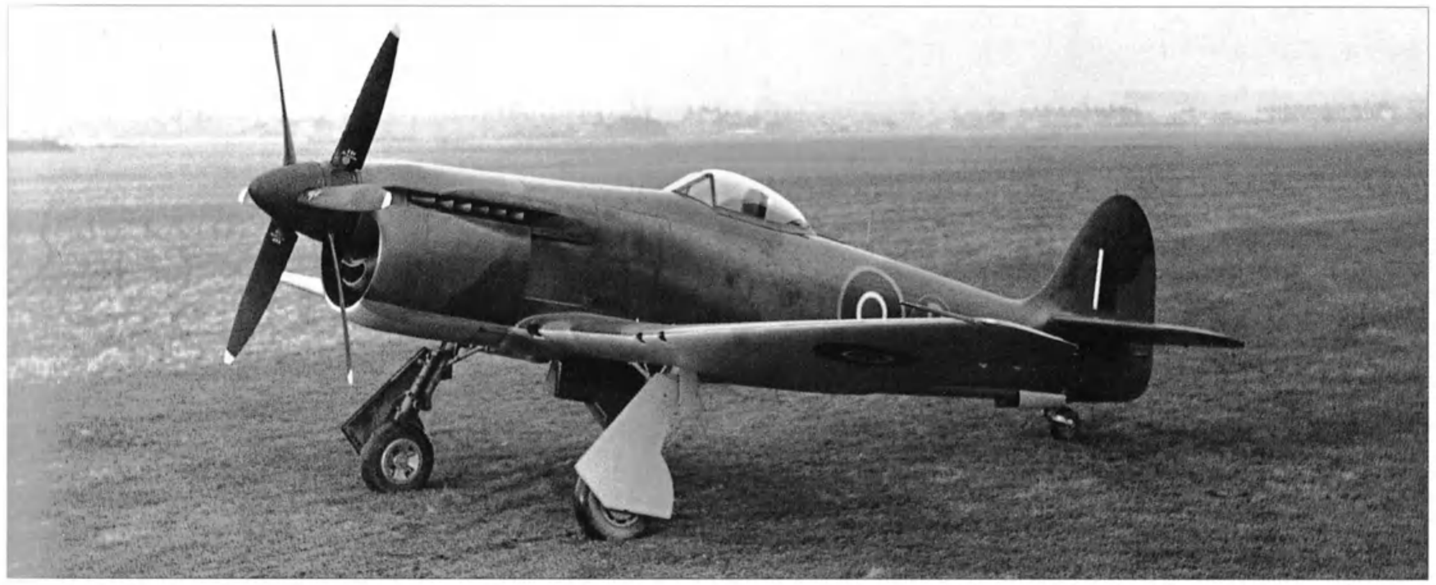
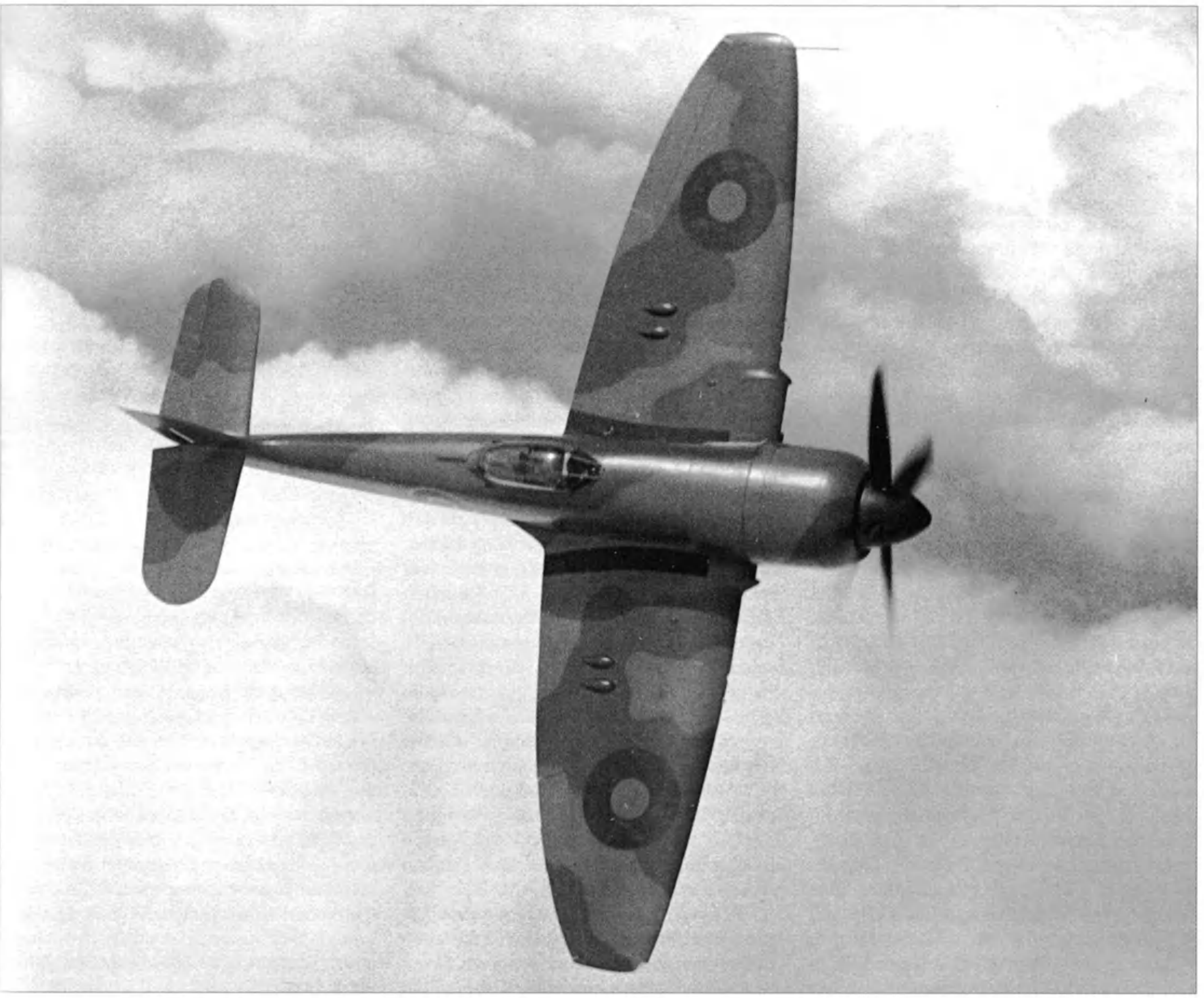
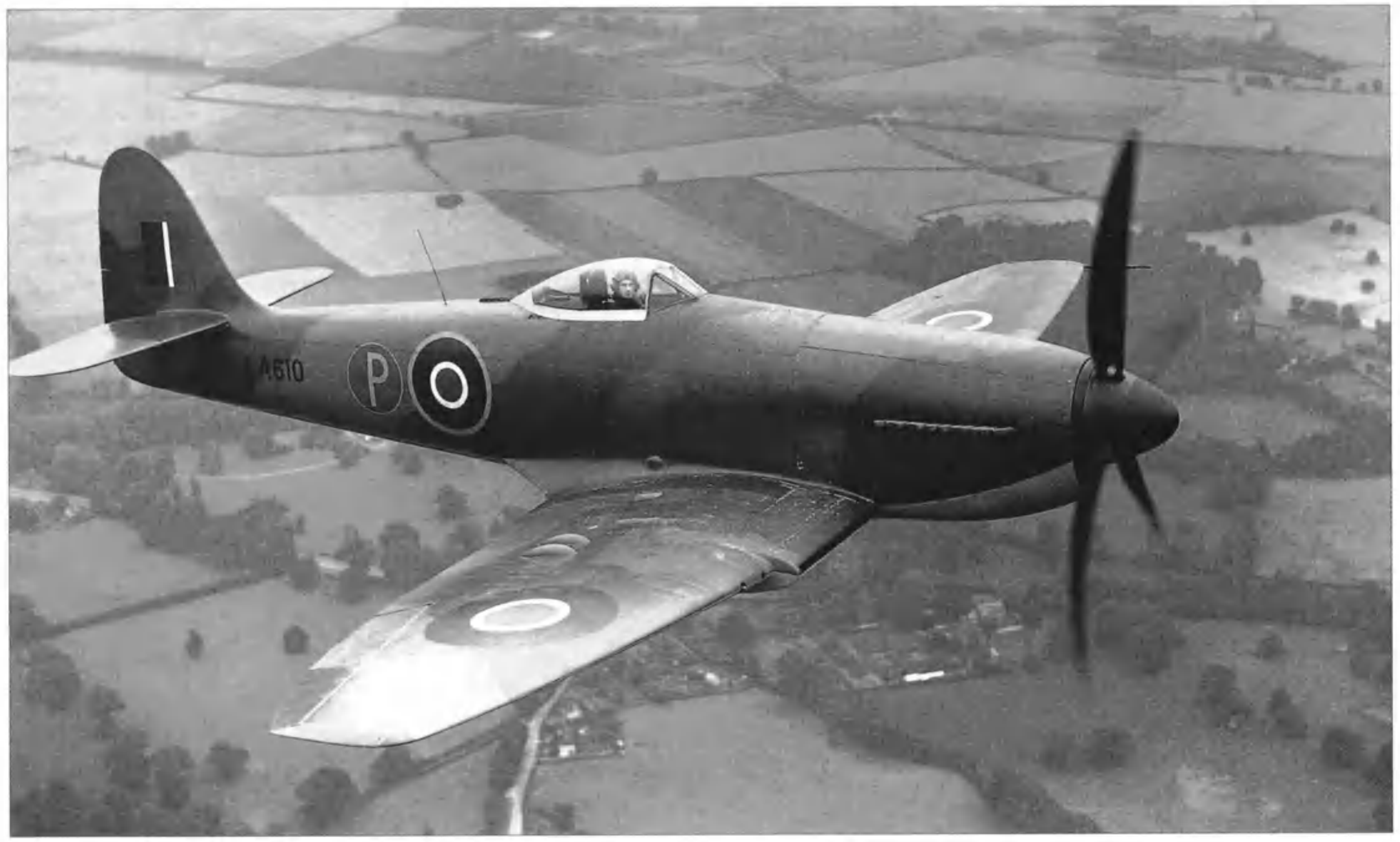






Previous pages, 24 and 25.

Page 24 bottom and page 25 top:
LA610 photographed at Langley in late 1944 or early 1945 in original configuration with Rolls-Royce Griffon engine and contra-rotating propellers. Chris Farara, Brooklands Museum

Page 24, top and page 25 bottom:
Two views of the Centaurus Fury prototype NX802. Chris Farara, Brooklands Museum

This page:

Above: **Fury LA610 as refitted with a Napier Sabre engine was one of the most beautiful piston fighters ever to fly.** Barry Guess, BAE Systems, Farnborough

from the Tempest of around 600lb (272kg) though soon afterwards the span had to be increased again slightly to allow the inboard guns to clear the propeller disc. A layout with a Sabre engine was completed on 2nd November 1942, a version with a Centaurus was finished on 4th December but work on the Griffon variant fell behind and its drawings were not ready until 18th September 1943.

Due to the Air Staff's demand for an air-cooled fighter, N E Rowe was particularly interested in the Centaurus radial and with the promise being shown by Camm's Centaurus-powered Tempest II. The predicted combat power of the CE.12.SM (Centaurus XII) of 2,000hp (1,491kW) at 18,500ft (5,639m) was practically ideal for the low/medium-altitude fighter the Air Staff had in mind where the objective was a maximum rate of climb between ground level and 20,000ft (6,096m). Discussions held at the Air Ministry on 17th January 1943 brought agreement that Bristol would be responsible for the Centaurus XII power egg while Hawker would provide the airframe. Specification F.2/43 was raised in February 1943 to cover the construction of two Bristol Centaurus prototypes, NX798 and NX802 and an order arrived at Kingston on 9th April. Contra-rotating propellers were requested for production aircraft but Bristol was informed in May that they were not required on these prototypes. By now the type had been named Fury.

In April 1943, Camm proposed that a new naval fighter specification, N.7/43, could be met by an adapted F.2/43 using a Centaurus XII with extra power. The suggestion was welcomed by Rowe and drawings, weight and performance estimates of this, the P.1022, were forwarded on 22nd April. On 12th July it was agreed with J D North of Boulton Paul that his firm would modify a Tempest for a trial installation of the wing folding, strengthened undercarriage and arrester gear that would turn the F.2/43 into N.7/43. Boulton Paul was then requested to build two naval Fury prototypes (with those parts standard to both versions being made by Hawker). Production of both versions side by side was to be undertaken by Hawker who stressed the importance of having contra-props on the Navy aircraft. This type, eventually to become the Sea Fury, really should be described in Chapter 10, but its background is so tied in with RAF developments that it is much more appropriate to cover it here. Specification N.22/43 was duly raised for the Sea Fury.

The need for contra-rotating propellers reflected a growing problem in that the steep gradient of power output that was being obtained with developments of the piston engine necessitated a much bigger airscrew to absorb it all. Keeping a single propeller called for ever larger diameters and consequently a taller undercarriage which, when retracted, had to be accommodated within the machine's structure, thus forcing the overall size of the conventional fighter to grow. By adopting a contra-prop, it became possible to increase the number of blades to six and utilise the extra power while keeping the diameter, and hence aircraft size, within bounds. However, a single five-bladed airscrew did in fact prove suitable for the Sea Fury.

The Griffon prototypes were not ordered until November 1943. By 14th June 1944 the prototype programme had become two F.2/43s with the Centaurus XII, two F.2/43s with the Griffon, one F.22/43 (land-based) prototype to be built by Hawker, only one N.22/43 now to be built by Boulton Paul with two more N.22/43s to come from Hawker. Development had also continued with numerous versions of the Tempest so, when Rowe suggested in late January 1944 that a Sabre V should be fitted by Napier to a Tempest V to accelerate that engine's air testing, Camm replied 'in view of the large number of test beds we are already committed to and the necessity for getting the maximum number of machines to the squadrons, we are scarcely able to keep pace with the prototype demand'.

Plans to build a Fury with a Sabre did not really get going until 1st October 1944 when MAP's J E Serby wrote suggesting that two prototype aircraft with the Sabre E.122 could be ready in about a year's time. A trial installation of a Sabre V in one F.2/43 was requested by MAP on 15th November and on 6th March 1945 Rowe declared that three Sabre prototypes would be needed. Prototype LA610 was to be converted from its Griffon configuration while the others would be new aircraft (VP207 and VP213).

The first Hawker F.2/43, NX798 with a Centaurus XII, left the Experimental Shop on 4th July 1944 and flew for the first time on 1st September. On Monday 4th September Camm reported to the Ministry that 'Lucas [the pilot] was extremely pleased with it, particularly with the feel of the controls which he said were like flying a Snipe' [the biplane Sopwith Snipe had been the RAF's first standard post World War One fighter and was renowned for its excellent handling]. Camm added that the ailerons were considered better than the spring tab Tempest ailerons and concluded 'it looks as though we have achieved something'. It was apparent that the aircraft showed considerable promise and had obviously superior qualities as a fighter over the Tempest on control, stability and view. By 4th October it was possible to compare the F.2/43's top speed to the level speeds of production Tempest Vs, the F.2/43 having already reached 453mph (729km/h) at 26,350ft (8,031m) compared to the Tempest V's 432mph (695km/h) at 18,500ft (5,639m).

The final line-up of Fury and Sea Fury prototypes is quite complex and most of them later received different engines and propellers.

i. NX798 with Centaurus XII, first flown 1st September 1944.

ii. LA610 with Griffon 85, first flown 27th November 1944. Little information has been traced relating to LA610's performance with Griffons and the machine appears to have flown relatively little with the Rolls-Royce engine. It was later fitted with a Centaurus and then a Sabre VII and made its first flight with the Sabre on 3rd April 1946. It was to show a rate-of-climb at sea level of 5,240ft/min (1,597m/min) and took 9.5 minutes to get to 30,000ft (9,144m); equivalent figures for the Centaurus Sea Fury were 4,400ft/min (1,341m/min) at sea level and 8.65 minutes to 30,000ft.

iii. NX802 – Centaurus XV, flown 25th July 1945.

iv. SR661 – Sea Fury semi-navalised prototype. In view of the urgency required this was adapted from the standard Fury with Centaurus XII and four-blade propeller but had an arrester hook; the wings could not be folded. First flew 21st February 1945.

v. SR666 – Fully navalised Sea Fury prototype with Centaurus XV and five-blade propeller, folding wings and hook. First flew 12th October 1945.

vi. VB857 – Fully navalised Sea Fury prototype with Centaurus XV, manufactured by Boulton Paul but assembly completed by Hawker, flown 31st January 1946.

vii. VP207 – Second Sabre VII prototype (VP213 not built).

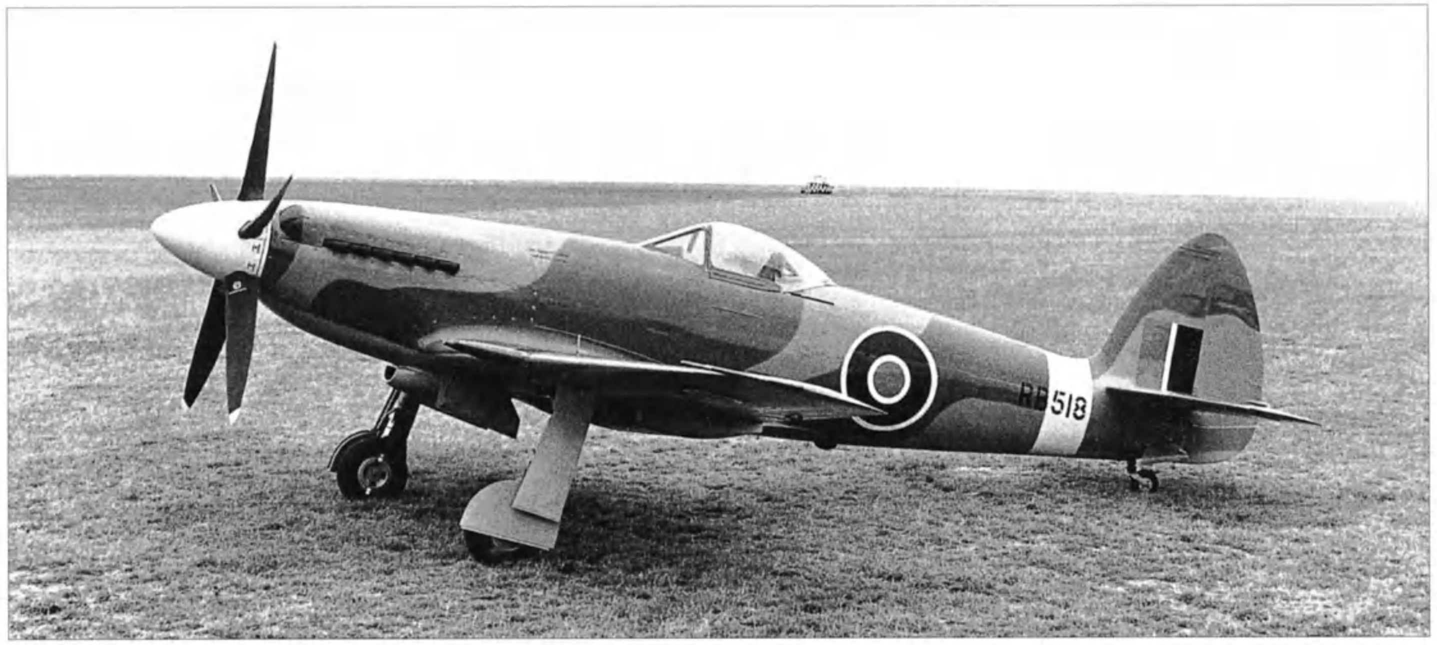
In April 1944 the Admiralty requested 100 N.22/43 aircraft a month. On 29th April Hawker received a contract from the Ministry for 200 F.2/43s and 200 N.22/43s and in November was advised that the F.2/43 would be named the Fury Mk.1 and the N.22/43 the Sea Fury Mk.10. Production was close and by April 1945 it was decided that all Fury production aircraft were to have the Sabre NS.83.SM (the Sabre VII) and all Sea Furies the Centaurus. In fact the Sabre would not be ready in time because of work on its Methanol/water injection so the Sea Fury received total priority over the Fury with deliveries to commence in January 1946; Fury deliveries were to start in August 1946.

However on 29th January 1946, after a production contract with Boulton Paul was cancelled, the Sea Fury order was cut from 200 to 100. Already, in February 1945, the Fury order had been cut by 50 and again in September to 120, and in February 1946 the number was reduced to 60. In mid-December 1945 it was agreed that the primary role of the Fury I was to be ground support, the first official intimation of such a change, the consequent requirements for low attack armour and additional rear fuel having important implications on its design. These changes were to prove difficult to achieve and Hawker was advised in late February 1946 that if the Fury I could not be used for ground attack purposes it was very unlikely that the Air Staff would have any need for it. On 14th August Hawker was told that the Fury I contract was cancelled. However, Centaurus 'land' Fury development was continued by Hawker as a private venture and was duly rewarded with production orders from overseas. Then, during 1946, the number of Sea Furies on order was increased again to help fill a gap in capability and eventually over 660 were built for the Fleet Air Arm and overseas customers.

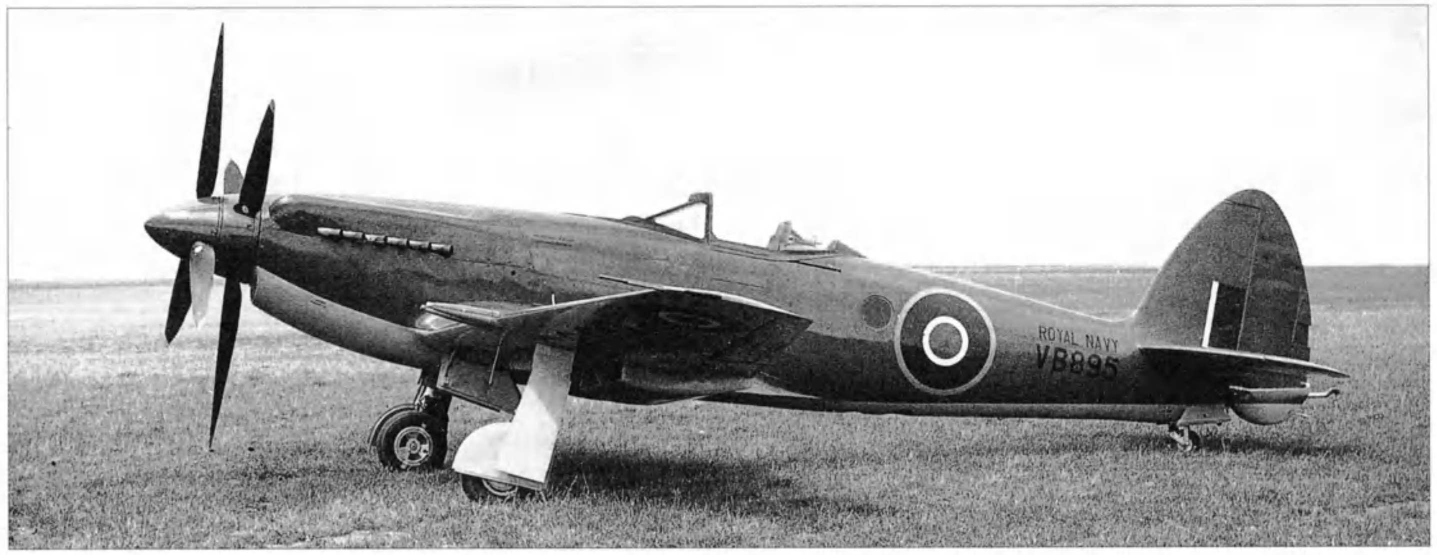
Supermarine Spiteful and Seafang

The final development of the Spitfire was to receive a new wing and a new name, Spiteful. In order to improve the Spitfire's rolling characteristics the designers were asked by the Ministry in 1942 to produce a new wing. At the same time it was also considered advantageous to introduce a laminar flow section on this wing and the result was known as the laminar flow wing or, sometimes, as the 'thin wing', although its t/c ratio was actually greater than the Spitfire's wing. Theoretically the laminar flow wing was designed to move the boundary layer transition point further aft on the wing surface so that the point at which the airflow over the wing became turbulent was delayed and drag was thus reduced. The new wing was considered in relation to aerodynamics, strength and operational requirements and the main benefits were expected to be an increased performance from the laminar flow, the avoidance of compressibility effects and improved rolling manoeuvrability from the smaller span. Compressibility was a growing problem caused by flying at speeds ever nearer to the speed of sound and increasingly more powerful engines meant that the aerodynamics needed to cater for this.

Supermarine's brochure describing a Spitfire with a laminar flow wing was completed in November 1942. The 210ft^2 (19.5m^2) wing area was 38.5ft^2 (3.6m^2) less than on the Spitfire 21, estimated weight was 200lb (91kg) less and the predicted increase in speed 55mph (88km/h). Three aircraft were ordered under specification F.1/43 which defined the new wing and called for a contra-rotating propeller. Initially this document was seen purely as an experimental specification to try out the wing and propellers as soon as possible and a maximum of four prototypes would be built. In addition the fuselage was to be a converted Mk.VIII Spitfire airframe but



During testing Supermarine Spiteful RB518 reached a speed of 494mph (795km/h) at 27,500ft (8,382m). Eric Morgan



Supermarine Seafang F Mk.32 prototype VB895. Eric Morgan

the choice of engine, Merlin or Griffon, was left to Supermarine's discretion. It was eventually decided that the first two prototypes should have Griffons and the third a Merlin, all with contra-rotating propellers. On 29th December 1942 the first pair of wings was expected to be ready in about eight months.

Among the requirements was that the new wing should be applicable to Spitfire Mk.VIII or Mk.21 airframes and would be applied to production machines of both marks towards the end of 1944. However, the laminar wing's design resulted in a major structural modification (a change to the spacing of the wing spars through the fuselage) which removed any hope of the new wing being directly applicable to the Mk.VIII or 21. In addition Supermarine was asked to provide a much superior pilot's view over the nose to any previous Spitfire and the company decided that when the laminar wing was fitted to production aeroplanes it would be associated with a fuselage that allowed the installation of either Griffon or Merlin with contra or single-rotating propeller. Supermarine referred to the new aircraft as the Type 371, although this project number was originally allocated just to the new wing.

A revised prototype programme now requested:

i. a Spitfire Mk.VIII fuselage with contra-rotating Griffon altered to accommodate the laminar flow wing
ii. one Type 371 with contra-rotating Griffon and
iii. one 371 with a single-rotating Merlin (the last was specified because there was no production programme for Merlin contra-rotating gears).

There were discussions for a new name for the 371, which the Air Staff felt was certainly applicable to the contra-rotating Griffon, and by 1st September 1943 the Spitfire Mk.21 with the standard wing was being referred to as the Victor I while Service aircraft with the laminar wing would be called Victor IIs. By March 1944 production 371s were being called 'Valiant' by the Ministry, but the new aircraft was eventually named Spiteful.

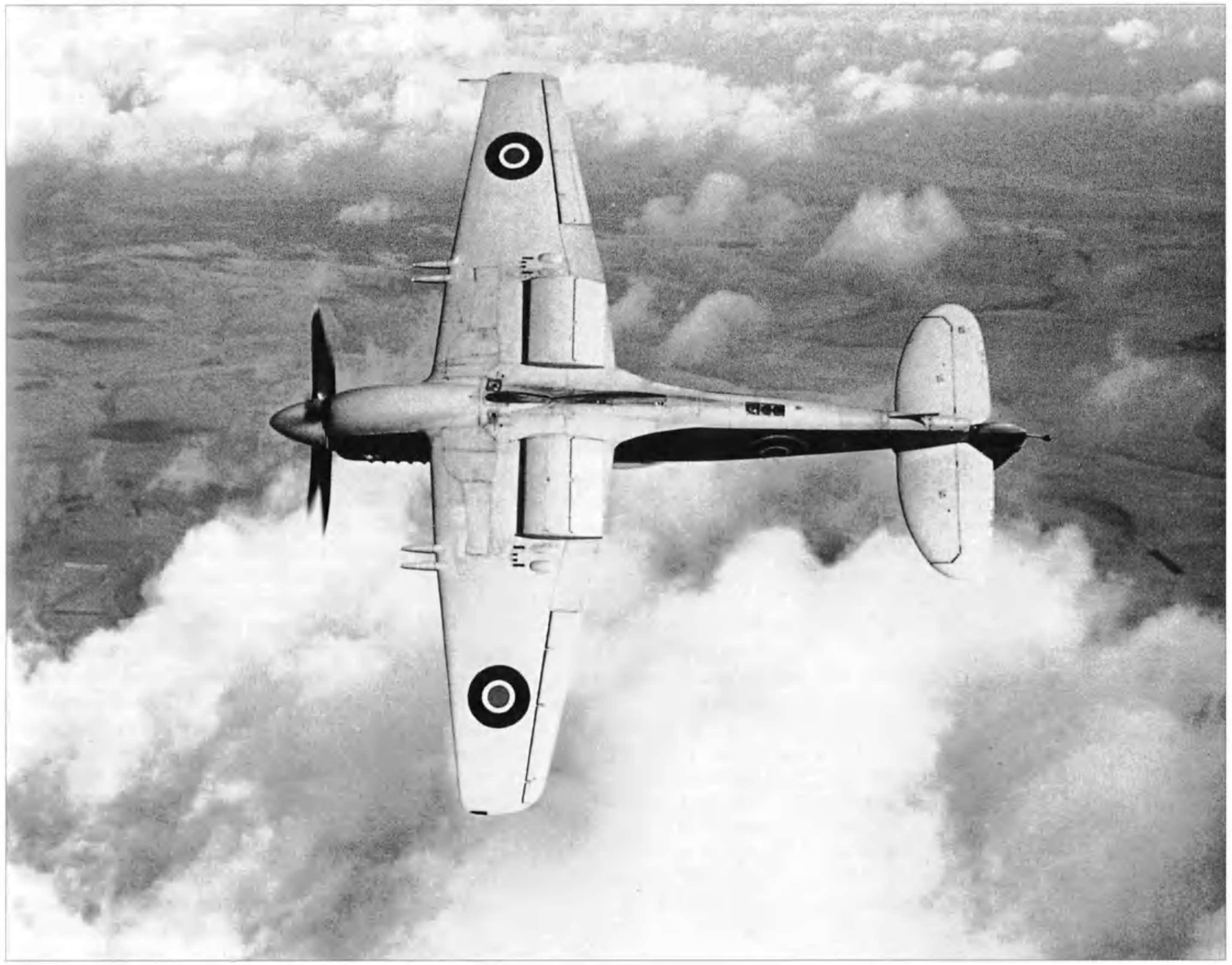
The first aircraft to fly with the new wing, Spitfire Mk.XIV NN660 converted as a hybrid Spiteful prototype, made its first flight on 30th June 1944. The first true prototype, NN664 completed to full F.1/43 production standards, flew on 8th January 1945 but subsequent flight trials indicated that the hoped for advances over the Spitfire had not been achieved. Tests on the modified Spitfire allowed a direct performance comparison to be made and the laminar wing did produce an increase in speed over the standard Spitfire wing, but it was disappointingly below the excess expected. Any slight degree of surface roughness, even from an impacted insect, could markedly reduce the speed. In addition the new version displayed poor stalling characteristics and more adverse compressibility characteristics than the old Spitfire wing.

Nevertheless extensive flight testing showed that the wing would be suitable for jet aircraft and it was eventually fitted to the Supermarine 392 jet fighter, which later served with the Fleet Air Arm as the Attacker (Chapter 11). Due to cutbacks brought about by the end of the war only 17 Spitefuls were completed from a planned run of 650 but several were used to improve the laminar wing's aerodynamics or to test alternative powerplants. One, RB518, recorded a speed of 494mph (795km/h) at 27,500ft (8,382m), the highest speed ever achieved by a British piston-powered aeroplane.

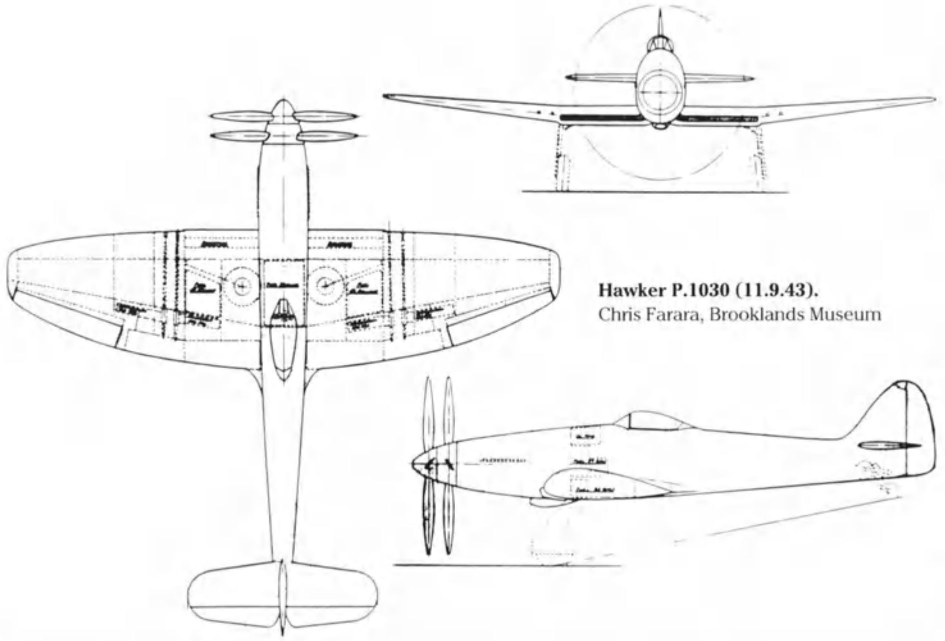
In October 1943 Supermarine began to consider fitting the laminar wing to the Seafire (Chapter 10) and proposed this as the private venture Type 382 with a Merlin 61. Initially this was not taken up but interest from the Admiralty began to grow and eventually Specification N.5/45 was written to cover a naval version of the Spiteful called Seafang. Spiteful RB520 was fitted with a hook and flew in early 1945 as an interim Seafang prototype but the first true prototype was VB895. A total of 150 Seafangs were ordered but only eight were completed and just two flown.

Eagle Fighters

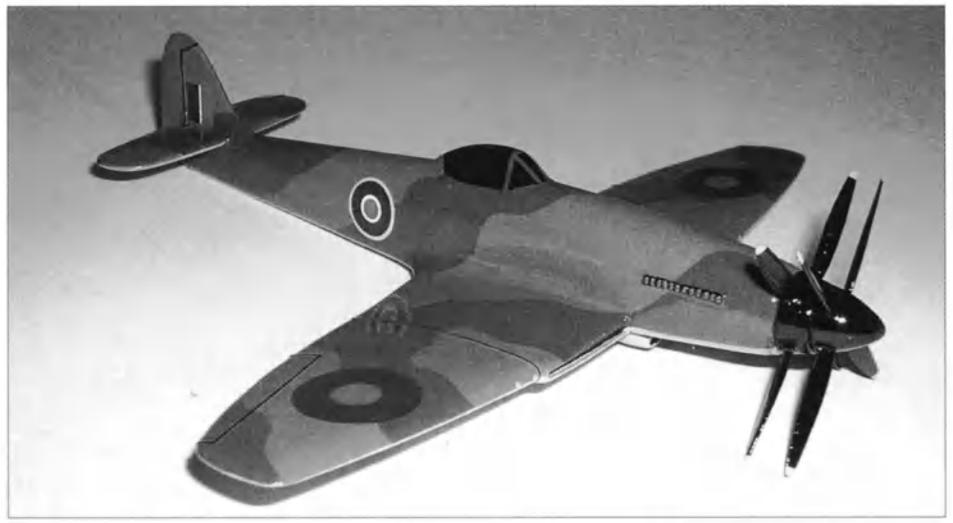
The ultimate development in British piston engines was to be the 3,500hp (2,610kW) Rolls-Royce 46H Eagle, a 24-cylinder H-shaped engine. The initial design project for what became the Eagle was begun in late 1942 but the engine was only ever flown on a Westland Wyvern Mk.I (Chapter 10); however, designs were prepared by Hawker and Supermarine to make use of it. The 'rivalry' between these two companies is well known, beginning with the Spitfire and Hurricane through to the Spiteful and Fury, and then into the jet age with the Attacker and Sea



This view of the Seafang shows off its laminar flow wing. Eric Morgan



Hawker P.1030 (11.9.43). Chris Farara, Brooklands Museum



Model of the P.1030. Joe Cherrie

Hawk and Swift and Hunter. Because of the different dates the following projects do not appear to have been in competition with one another but they do represent the ultimate in piston fighter design from the two famous British aircraft manufacturers.

Hawker P.1027 and P.1030

In 1943 Hawker completed a drawing for its P.1027 project that was essentially a developed Tempest fitted with a Rolls-Royce 46H. It had four 20mm cannon in the wings, contra-rotating propellers and a radiator placed beneath the fuselage about half way back directly under the pilot (rather like the Merlin-powered North American P-51 Mustang). Span was 41ft (12.5m) and length 37ft 3in (11.4m). The P.1030 of September 1943 was very similar but larger and had its radiators moved to the wing leading edges (the arrangement tried earlier on the Tempest I). P.1030 does not appear to have been produced as a full brochure but a four page report describing the results of wind tunnel testing and weight assessment was prepared.

The project was designed when the 46H was still a paper engine but, using estimates based on Rolls-Royce figures for the Merlin and Griffon, Hawker expected it to give 4,020hp (2,998kW). It was assumed that this power could be obtained with increased boost to 23lb/sq.in (1.62kg/sq.cm) and using '140' grade fuel together with 60% intercooling. The wings would be built in one piece and 252gal (1,146lit) of internal fuel would be carried in tanks placed in the inner wings and in the fuselage between the engine and cockpit. The diameter of the two four-blade contra-rotating propellers (13ft 6in [4.1m]) had been chosen to give a level balance between climb and maximum speed efficiency but it was emphasized that very much better efficiencies, both in climb and level speed, could be obtained if a two-speed propeller gearing was fitted. The document stressed that this propeller development should be pressed forward if engines of the 46H's power were to be put into production.

P.1030's maximum level speed was calculated to be 509mph (819km/h) at 20,000ft (6,096m), rate of climb 6,400ft/min (1,951m/min) at sea level and 4,680ft/min (1,426m/min) at 20,000ft, time to 20,000ft 4 minutes and 30,000ft (9,144m) just under 7 minutes, and ceiling in excess of 42,000ft (12,802m). Later, in 1944, Hawker proposed a Fury development fitted with an Eagle called the P.1032, but to date no drawing of this has been traced.

Supermarine 391

This project appeared some time after the P.1030 but did have a full brochure written around it, albeit quite a slim one. It was actually designed as a 'High-Performance Aeroplane for the Royal Navy' capable of operating from a carrier and so should really belong in Chapter 10, but it is better placed alongside the P.1030 (it is not known if the 391 was designed to compete with the Westland Wyvern). The 391 had the Spiteful/Seafang's laminar flow wing (which could be folded to a width of 21ft [6.4m]) and, though primarily a fighter, the aircraft could be converted to carry bombs, rocket projectiles or one 18in (45.7cm) Mk.XV torpedo. The basic aeroplane had four 20mm cannon in the wings but two would be taken out when carrying the torpedo. Internal fuel totalled 330gal (1,500lit).

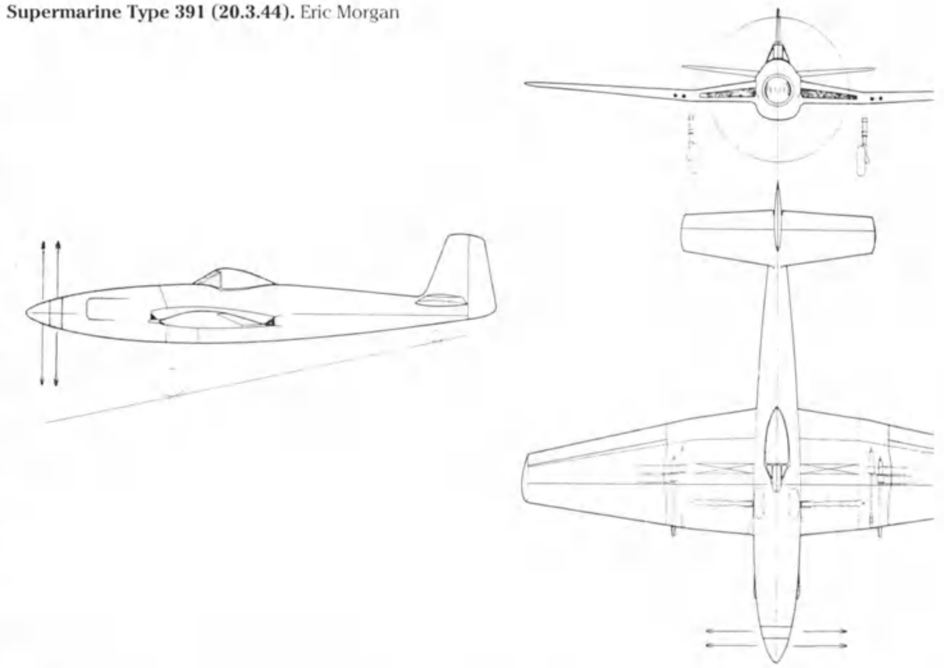
The engine was a 46-H-24 (RH.2.SM) with contra-rotating propellers and more mature performance figures were now available for this unit – combat power would be 3,550bhp (2,647kW) up to 6,000ft (1,829m) in MS gear and 3,260bhp (2,431kW) in FS gear up to 18,000ft (5,486m). As a fighter at 15,750lb (7,144kg) weight the 391 showed an initial rate of climb of 4,800ft/min (1,463m/min), time to 20,000ft (6,096m) of 4.35 minutes, service ceiling 41,100ft (12,527) and still air range 765nm (1,417km); equivalent figures when carrying the torpedo at 17,250lb (7,825kg) all-up-weight were 4,200ft/min (1,280m/min), 5.0 minutes, 39,300ft (11,979m) and 895nm (1,658km). Sadly, none of these very exciting Eagle-powered designs was ever close to being built.

Martin-Baker MB.3, MB.4 and MB.5

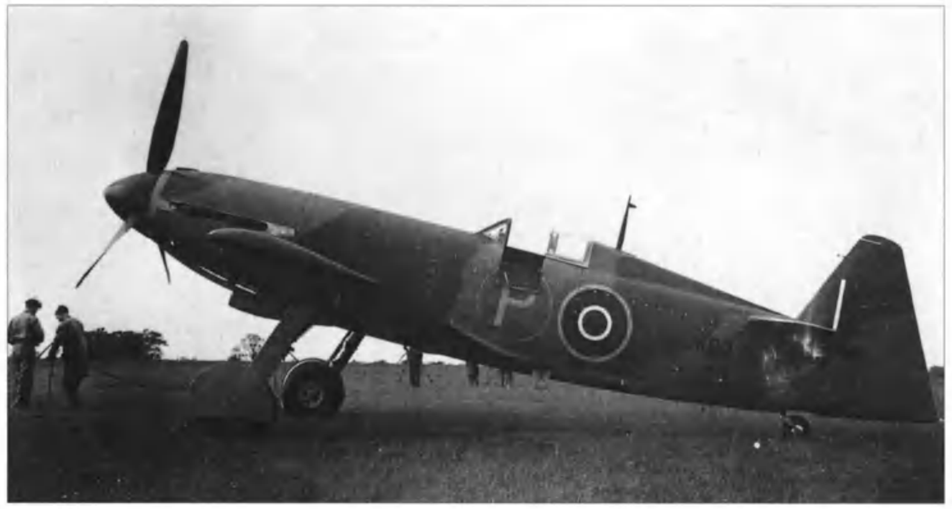
To close this chapter we must take a look at the designs of a company that was really an outsider in the aircraft industry, yet whose final product was one of the most outstanding of British piston fighters. The story of James Martin and Capt Val Baker forming the small Martin-Baker Aircraft company belongs elsewhere but on 3rd August 1938 the team flew a single-seat fighter called the MB.2 powered by a Napier Dagger engine. This was followed by the private venture MB.3 of which three were ordered against Specification F.18/39, written around the type in May 1939. The MB.3 had six wing-mounted 20mm cannon and, when flown, was fitted with a Napier Sabre II. It was expected to achieve 400mph (644km/h) at 15,000ft (4,572m) and the only example to be built, R2492, flew on 3rd August 1942; sadly it crashed just over a month later killing Capt Baker.

By this time constant delays and late delivery with the MB.3 had ensured that the type would not receive a production order (the Ministry considered that the fighter was outdated before it flew). However, James Martin had always wanted to use a Rolls-Royce Griffon on his fighters and finally got the chance to fit one in the much redesigned MB.5. The Bristol Centaurus was considered as an alternative and preliminary drawings of the MB.4 with this engine were completed, but once the Griffon was available the MB.4 and all other alternatives were dropped. The MB.5 was also re-engineered with a four cannon wing, teardrop canopy and rear fuselage radiator.

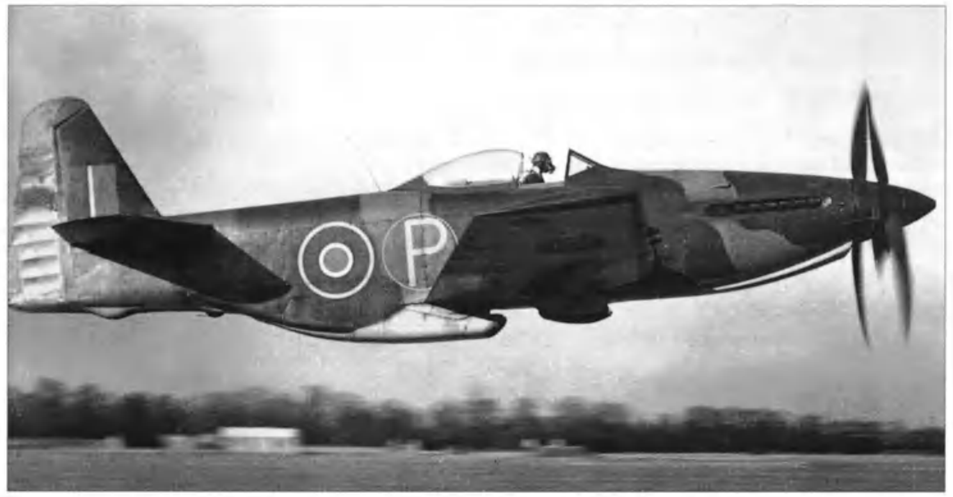
The first and only MB.5, R2496, was built under the same F.18/39 contract and made its maiden flight on 23rd May 1944; it proved to be a very fine aeroplane and few piston fighters would beat its top speed of 460mph (740km/h) at 20,000ft (6,096m). A&AEE Boscombe Down's assessment noted that the general layout of the MB.5 was 'excellent and infinitely better, from the engineering and maintenance point of view, than any other similar type of aircraft.' It was highly rated by all of the pilots who flew it and made a very good gun platform and a spectacular aerobatic display aircraft, but the end of the war and the slow progress made by the company in getting the machine ready (partly through a lack of facilities) ensured that it too remained a prototype. After the MB.5 Martin produced one or two jet fighter designs before concentrating on ejection seats for military aircraft, a product that made his company world famous.



Supermarine Type 391 (20.3.44). Eric Morgan



Martin-Baker MB.3. Martin-Baker



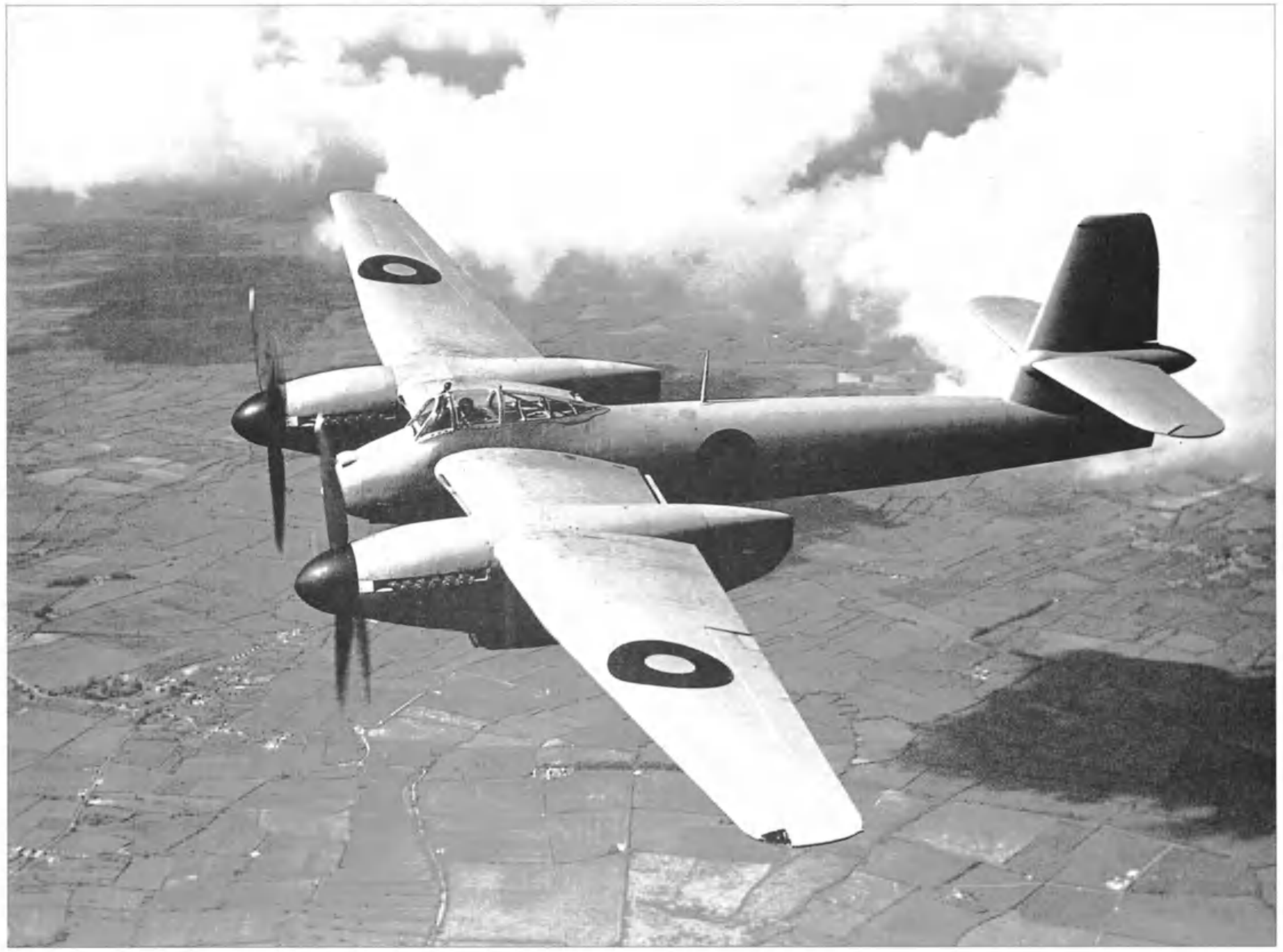
The spectacular Martin-Baker MB.5. Martin-Baker

RAF Fixed-Gun Fighters – Estimated Data

Project	*Span ft in (m)*	*Length ft in (m)*	*Gross Wing Area ft² (m²)*	*Max Weight lb (kg)*	*Engine hp (kW)*	*Max Speed / Height mph (km/h) / ft (m)*	*Armament*
Hawker Hurricane Mk.1 (flown)	40 0 (12.1)	32 3 (9.8)	258 (24.0)	6,793 (3,081)	1 x Merlin III 1,030 (768)	320 (515) at 17,500 (5,334)	8 x 0.303in (7.7mm) mg
Supermarine Spitfire Mk.I (flown)	36 10 (11.2)	29 11 (9.1)	242 (22.5)	6,256 (2,838)	1 x Merlin III 1,030 (768)	355 (571) at 19,000 (5,791)	8 x 0.303in mg
Supermarine Spitfire Mk.XIV (flown)	36 10 (11.2)	32 8 (10.0)	242 (22.5)	8,488 (3,850)	1 x Griffon 65 2,050 (1,529)	448 (721) at 26,000 (7,925)	2 x 20mm cannon, 4 x 0.303in mg
Specification F.18/37							
Gloster F.18/37	46 0 (14.0)	39 0 (11.9)	290 (27.0)	10,375 (4,706)	1 x Sabre	418 (673) at 17,500 (5,334)	12 x 0.303in mg
Supermarine 324	41 0 (12.5)	31 10 (9.7)	290 (27.0)	10,766 (4,883)	2 x Merlin 2.SM 1,265 (943)	450 (724) at 18,250 (5,563)	12 x 0.303in mg
Supermarine 324	41 0 (12.5)	31 6 (9.6)	290 (27.0)	10,000 (4,536)	2 x Taurus 3.SM 1,250 (932)	421 (677) at 16,500 (5,029)	12 x 0.303in mg
Supermarine 325	43 0 (13.1)	32 2 (9.8)	306 (28.5)	11,166 (5,065)	2 x Merlin 2.SM 1,265 (943)	458 (737) at 18,250 (5,563)	12 x 0.303in mg
Supermarine 325	43 0 (13.1)	31 0 (9.5)	306 (28.5)	10,511 (4,768)	2 x Taurus 3.SM 1,250 (932)	429 (690) at 16,500 (5,029)	12 x 0.303in mg
Supermarine 327	40 0 (12.2)	33 6 (10.2)	304 (28.3)	11,312 (5,131)	2 x Merlin 2.SM 1,265 (943)	465 (748) at 22,000 (6,706)	6 x 20mm cannon
Hawker Tornado (flown)	42 0 (12.8)	32 6.5 (9.9)	283 (26.3)	10,600 (4,808)	1 x Vulture 5 1,800 (1,342)	425 (684)	12 x 0.303in mg
Hawker Typhoon Mk.IB (flown)	41 7 (12.6)	31 11 (9.7)	279 (25.9)	11,400 (5,171)	1 x Sabre II 2,180 (1,626)	405 (652) at 18,000 (5,486)	4 x 20mm cannon, 8 rocket projectiles
Hawker Tempest Mk.I (flown)	41 0 (12.5)	34 2 (10.4)	302 (28.1)	11,300 (5,126)	1 x Sabre IV 2,500 (1,864)	466 (750) at 24,500 (7,468)	4 x 20mm cannon
Hawker Tempest Mk.III	43 0 (13.1)	34 3 (10.4)	307 (28.6)	10,400 (4,717)	1 x Griffon IIB	400 (644) at 22,000 (6,706)	4 x 20mm cannon
Hawker Tempest Mk.IV	43 0 (13.1)	34 3 (10.4)	307 (28.6)	10,700 (4,854)	1 x Griffon 61	430 (692) at 31,500 (9,601)	4 x 20mm cannon
Hawker Tempest Mk.V (flown)	41 0 (12.5)	33 8 (10.3)	302 (28.1)	11,510 (5,221)	1 x Sabre IIB 2,420 (1,805)	435 (700) at 17,500 (5,334)	4 x 20mm cannon
Hawker Tempest Mk.II (flown)	41 0 (12.5)	34 5 (10.5)	302 (28.1)	11,900 (5,398)	1 x Centaurus V 2,590 (1,931)	440 (708) at 17,000 (5,182)	4 x 20mm cannon
Specification F.6/42							
Airspeed AS.56	40 0 (12.2)	30 0 (9.1)	237 (22.0)	9,856 (4,471)	1 x Sabre IV	492 (792) at 23,400 (7,132)	4 x 20mm cannon
Boulton Paul P.98 (Sabre)	34 6 (10.5)	?	247 (23.0)	9,892 (4,487)	1 x Sabre	446 (718) at 20,000 (6,096)	4 x 20mm cannon
Boulton Paul P.98 (Griffon)	33 0 (10.1)	?	225 (20.9)	8,861 (4,019)	1 x Griffon	440 (708) at 20,000 (6,096)	4 x 20mm cannon
Folland Fo.117	36 0 (11.0)	31 6 (9.6)	224 (20.8)	9,749 (4,422)	1 x Centaurus	467 (751) at 20,000 (6,096)	4 x 20mm cannon
Hawker P.1018	37 0 (11.3)	?	245 (22.8)	9,859 (4,472)	1 x Sabre 43	465 (748) at 22,000 (6,707)	4 x 20mm cannon
Hawker P.1019	36 0 (11.0)	?	235 (21.9)	9,019 (4,091)	1 x Griffon 61	445 (716) at 22,000 (6,707)	4 x 20mm cannon
Hawker P.1020	36 0 (11.0)	?	235 (21.9)	9,443 (4,283)	1 x Centaurus	450 (724) at 22,000 (6,707)	4 x 20mm cannon
Supermarine F.6/42	40 2.5 (12.3)	?	248 (23.1)	8,750 (3,969)	1 x Griffon 61	450 (724) at 21,000 (6,401)	4 x 20mm cannon
Westland F.6/42	35 6 (10.8)	?	206 (19.2)	8,255 (3,744)	1 x Griffon 61	443 (713) at	4 x 20mm cannon
Hawker Fury Mk.I (flown)	38 4.5 (11.7)	34 8 (10.6)	284.5 (26.5)	12,120 (5,498)	1 x Sabre VII 3,055 (2,278)	483 (777) at 18,500 (5,639)	4 x 20mm cannon, 2 x 1,000lb (454kg) bombs
Hawker Fury	38 4.5 (11.7)	34 7 (10.5)	280 (26.0)	11,675 (5,296)	1 x Centaurus XV 2,400 (1,790)	455 (732) at 24,000 (7,315)	4 x 20mm cannon, 2 x 1,000lb (454kg) bombs, RPs
Supermarine Spiteful Mk.XIV (flown)	35 0 (10.7)	32 11 (10.0)	210 (19.5)	8,950 (4,060)	1 x Griffon 69 2,050 (1,529)	465 (748) at 26,000 (7,925)	4 x 20mm cannon, 2 x 1,000lb (454kg) bombs, RPs
Hawker P.1030	42 0 (12.8)	39 9 (12.1)	350 (32.3)	14,200 (6,441)	1 x 46H.24 4,020 (2,998)	509 (819) at 20,000 (6,096)	4 x 20mm cannon
Supermarine 391	43 6 (13.3)	39 9 (12.1)	335 (31.2)	15,750 (7,144), 17,250 (7,825) with TT	1 x 46H.24 3,550 (2,647)	546 (879) at 25,000 (7,620)	4 x 20mm cannon, 1 x 18in (45.7cm) torpedo, bombs, rocket projectiles
Martin-Baker MB.5 (flown)	35 0 (10.7)	37 9 (11.5)	263 (24.5)	12,090 (5,484)	1 x Griffon 83 2,305 (1,719)	460 (740) at 20,000 (6,096)	4 x 20mm cannon

Chapter Two

Twin-Engined Fixed-Gun Fighters

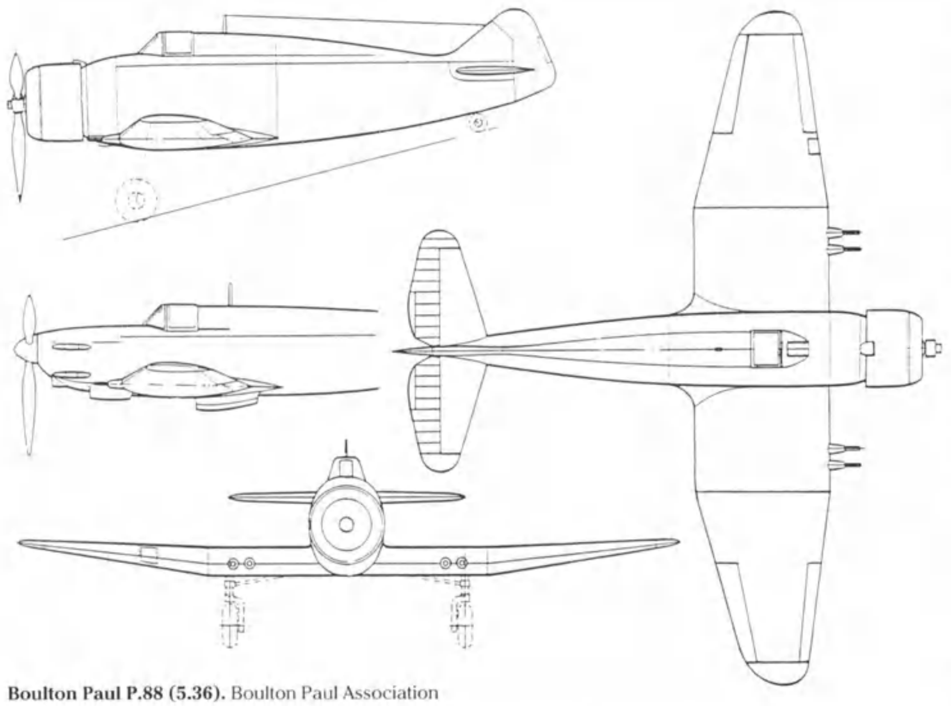


On 20th April 1944 a set of publicity photographs were taken of Westland Welkin DX318 and included this superb view. Fred Ballam, Westland

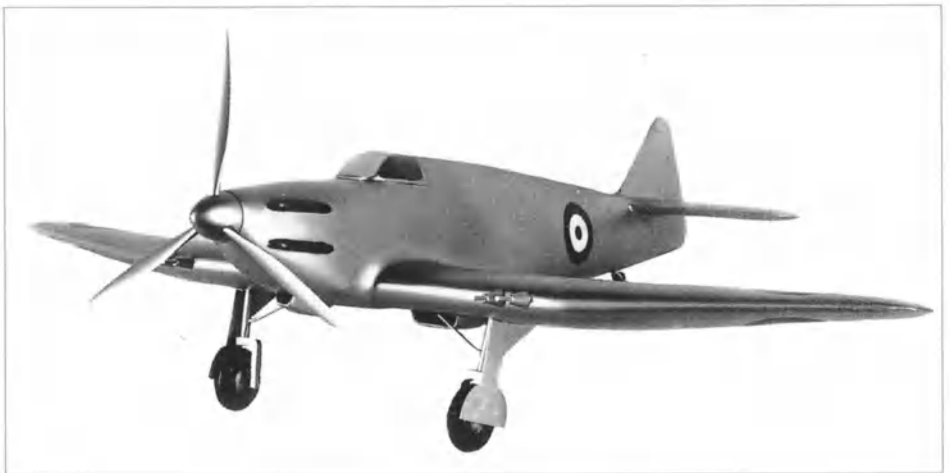
The development of the RAF's twin-engined fighters ran concurrently with the single-engined types described in the previous chapter. Once again there is some crossover between single and twin-engine types because a few of the tenders to the following specifications had just one engine and they need to be described under the correct requirement.

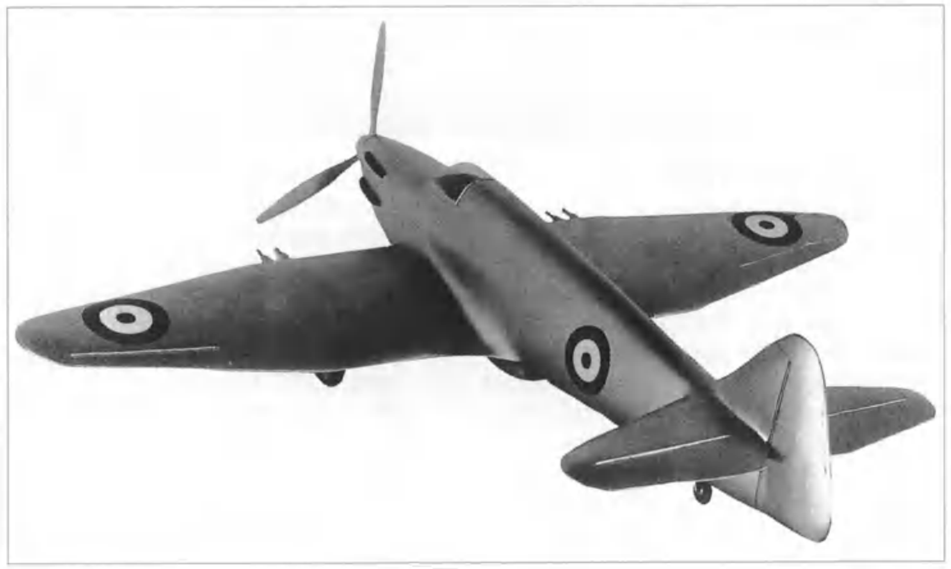
Specification F.37/35 Westland Whirlwind

As noted in Chapter 1, it was acknowledged during the mid-1930s that for a fighter to be fully effective it needed a very heavy armament of up to eight machine guns, but even more hitting power was offered in the form of four French Hispano-Suiza 20mm cannon with explosive bullets. The arrival of this impressive weapon was to bring about a complete revolution in fighter armament once metal structures were strong enough to absorb the heavy recoil. At the time, much attention was being given to the weapon overseas and the Air Staff felt that the need for a British experimental aircraft fitted with 20mm was now very urgent. F.37/35 requested a top speed at least 40mph (64km/h) in excess of contemporary bombers, giving a minimum maximum of 330mph (531km/h) at 15,000ft (4,572m). The Deputy Chief of the Air Staff wrote 'if the type were successful it would provide … the most powerful fighter likely to be produced for some time'. It would be a radical departure from any existing types and five companies responded with eight designs.



Boulton Paul P.88 (5.36). Boulton Paul Association





Models of the Boulton Paul P.88B with Vulture engine. Peter Green

Boulton Paul P.88

Two similar designs were proposed powered by either a single Bristol Hercules HE.1.SM (P.88A) or Rolls-Royce Vulture (P.88B). They had two 20mm in each wing-mounted on their sides either side of a beam fitted between the wing spars. P.88A carried 104gal (473lit) of fuel and was expected to show a maximum rate of climb of 3,500ft/min (1,067m/min) at 5,000ft (1,524m) and a service ceiling of 39,500ft (12,040m), the larger P.88B's figures were 133gal (605lit), 3,400ft/min (1,036m/min) at 15,000ft (4,572m) and 38,000ft (11,582m). A contract for two aeroplanes, L6591 and L6592, was placed in December 1936 but was cancelled on 6th January 1937.

Bristol Type 153

Bristol also produced two designs to F.37/35, one called the Type 153 which had a single Bristol Hercules plus the twin-engine 153A below. The 153 was a development of the experimental Type 151 high-speed research aircraft proposed to 35/35 in early 1936 and had the same fuselage and tail unit but larger wings, which reduced the estimated top speed to 357mph (574km/h) from the 151's 440mph (708km/h). Initial rate of climb was 3,580ft/min (1,091m/min) and service ceiling 33,200ft (10,119m). Due to the thin aerofoil section, the four 20mm guns were mounted in underwing fairings but the worry of stowing such large weapons in cantilever wings outboard of the propeller disc prompted Bristol's designers, Frank Barnwell and Leslie Frise, to produce the alternative 153A.

Bristol 153A

From many points of view it was considered much more satisfactory to mount the guns on the centreline with two smaller engines set on the wings. The 153A had two Bristol Aquila engines, twin end plate fins and rudders and a slim fuselage; the wingspan was the same as the 153 but the wing area and weight were increased. The cannon armament was fitted in the lower fuselage nose which itself was level with the centre-wing leading edge (and gave a strikingly similar appearance to the Grumman XF5F-1 Skyrocket, a contemporary project from America which flew on 1st April 1940). A 42.5gal (193lit) fuel tank was placed in each wing between the fuselage and engine nacelle.

Hawker F.37/35

This was a Hurricane with four 20mm Oerlikon cannon mounted in the wing outer panels; the type's general shape was unchanged.

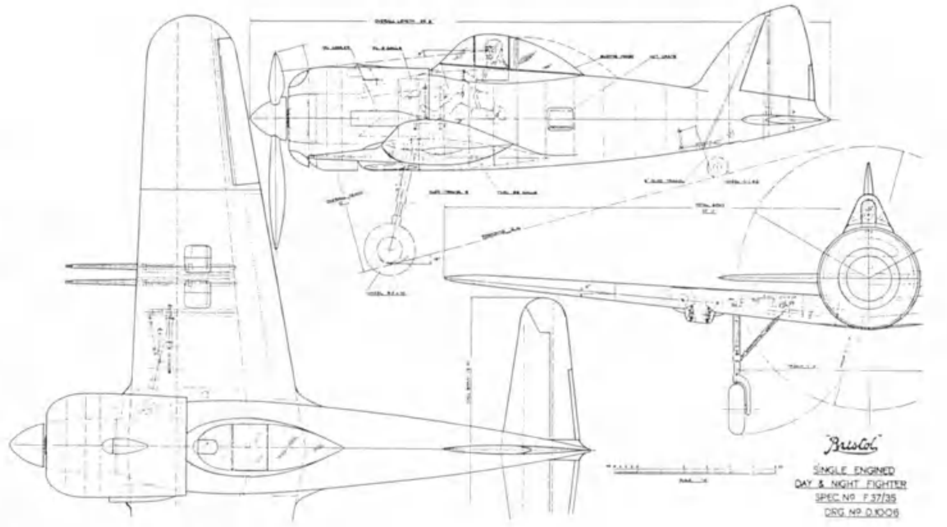
Supermarine 312

Spitfire designer R J Mitchell's last fighter design, this was an adapted Spitfire with four 20mm Oerlikon cannon mounted in modified wings well outside the airscrew disc. The Spitfire's radiator was replaced by an inlet under the fuselage but the fuselage, engine installation, tail unit and chassis were unaltered. When the project was proposed the then experimental F.37/34 (Spitfire) had almost completed its contractor's flight trials and shown itself to be a very satisfactory aeroplane of high performance and no vices. Supermarine felt that if a production order was placed for the F.37/34, the provision of an alternative set of wings would enable one machine to fulfil F.37/35. If hopper type ammunition boxes were available the guns could be housed completely inside the wings (except for the outer barrels); if not then a slight excrescence on each bottom wing surface would be necessary to fair in the ammunition drums, but this would add minimal drag. Apart from the gun mountings the wing would be unaltered. Estimated time to 20,000ft (6,096m) was 9.5 minutes and service ceiling 31,000ft (9,449m).

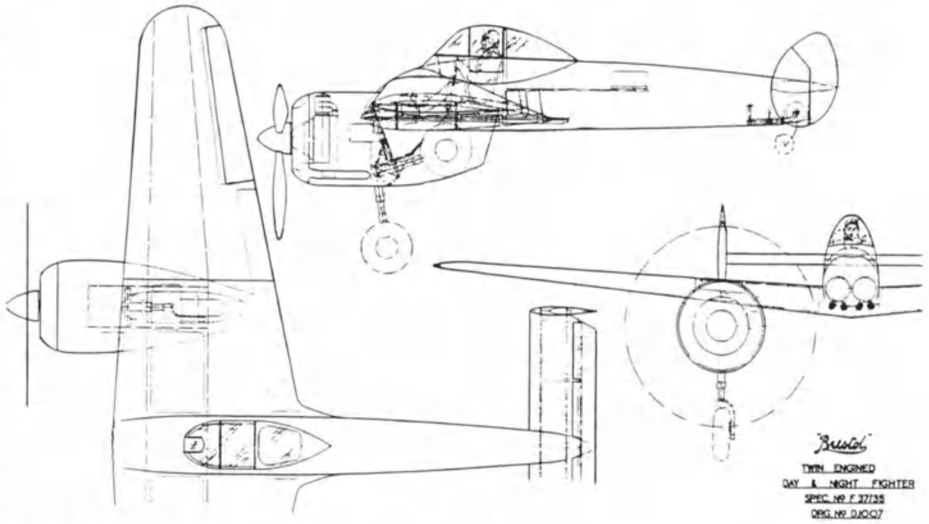
Supermarine 313

This twin-engine project used Rolls-Royce Goshawks or, as an alternative, Aero Engines Ltd (Hispano) 12Y glycol-cooled units. The radiators were buried in the inner wing and fed by small profile inlets under the leading edges while, structurally the design was similar to the Supermarine F.7/30 (Type 224) and F.37/34. It was intended to use the well-tried Supermarine single-spar cantilever wing with 'D'-shaped nose torsion box. The single spar was very favourable for the engine installation, chassis retraction (into the engine nacelles) and fuel tank location and the whole wing was metal covered with the smooth leading edge flush-riveted to present an ideally smooth surface to the airstream. Supermarine noted that this type of wing was very favourable in terms of flutter, aileron reversal and other flexibility problems.

A battery of four 20mm cannon was grouped and completely enclosed in the nose (if 12T engines were used, two additional cannon could be fitted to fire through the airscrew hubs) and the front section of the fuselage was hinged to allow the guns to be removed. The fuselage itself was metal monocoque which combined a smooth sur-

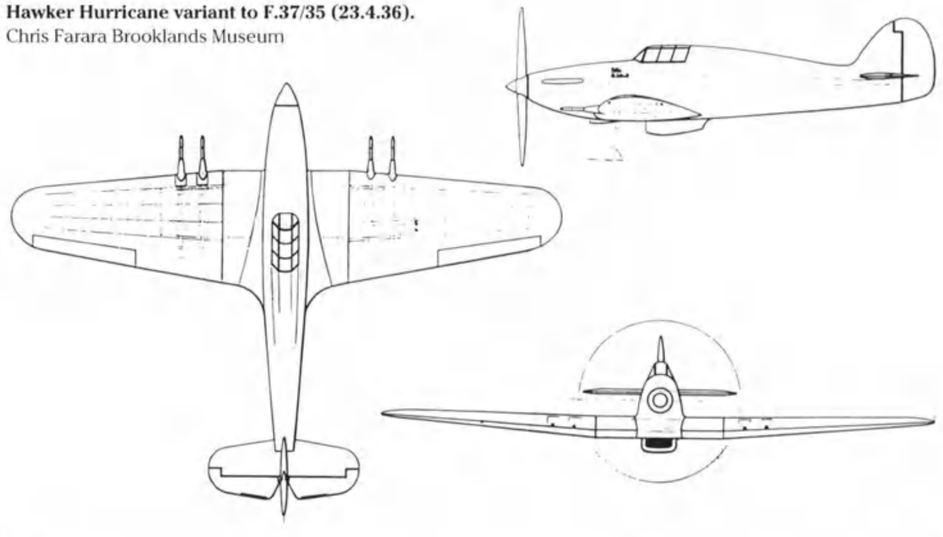


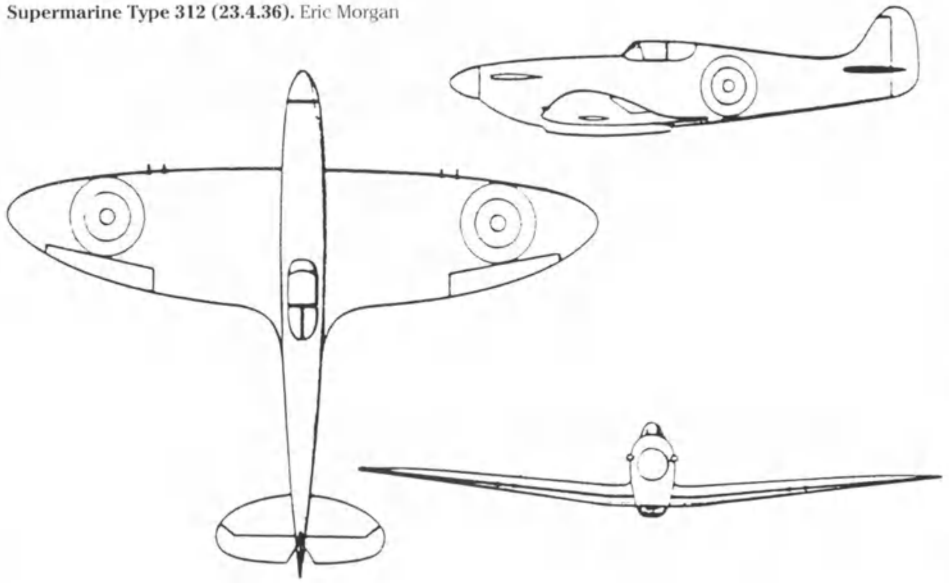
Bristol Type 153 (30.4.36). Jim Oughton



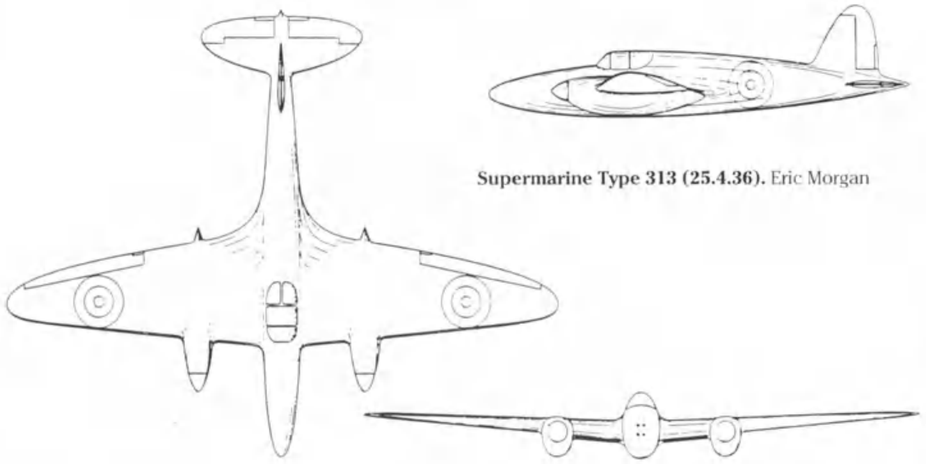
Bristol Type 153A (5.36). Duncan Greenman Bristol AIR*chive*

Hawker Hurricane variant to F.37/35 (23.4.36).
Chris Farara Brooklands Museum

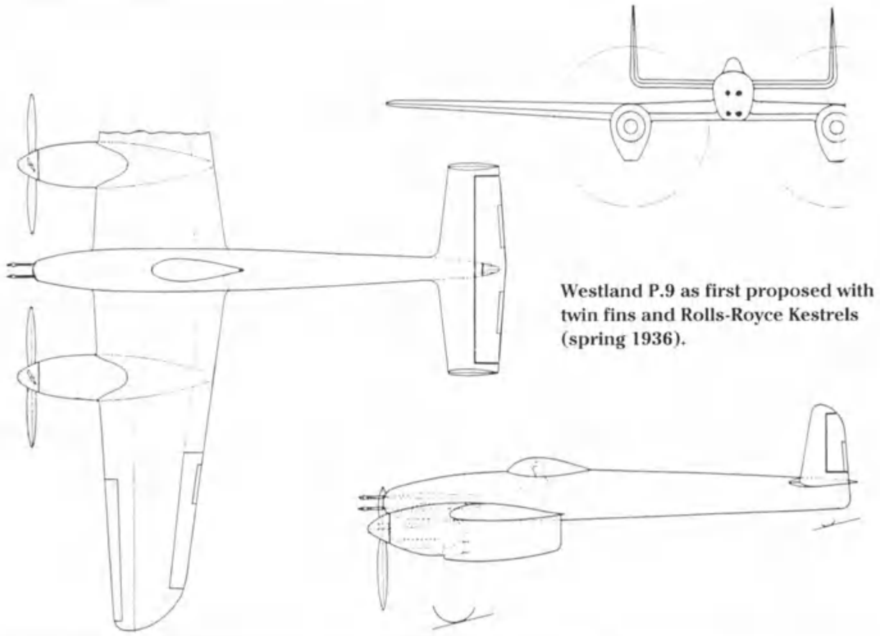




Supermarine Type 312 (23.4.36). Eric Morgan



Supermarine Type 313 (25.4.36). Eric Morgan



Westland P.9 as first proposed with twin fins and Rolls-Royce Kestrels (spring 1936).

face, high torsional rigidity and light weight. Care had been taken to make the design as clean as possible and as small as possible with a span only slightly greater than the Type 224. The 313 would take 7.5 minutes to get to 20,000ft (6,096m) and its service ceiling was 34,000ft (10,363m). Fitting 12Y engines would add an extra 500lb (227kg) to the maximum weight and give a performance approximately equal to that quoted for the Goshawk, except that rate of climb below 15,000ft (4,572m) would be slightly better due to the different supercharger height while the ceiling was slightly lower.

The brochure also noted that the 313 could also be used as a light bomber since space was available in the fuselage behind the pilot to house four 500lb (227kg) bombs. Another crewman would be added, two cannon would be taken out and the all-up-weight would reach 10,700lb (4,854kg). One prototype Supermarine F.37/35, L6593 (actually thought to be a Type 312 rather than a 313), was provisionally ordered in December 1936 but was cancelled on 28th January 1937.

Westland P.9

A twin Rolls-Royce Kestrel K.26 project closely resembling the eventual Whirlwind but with a low tail and twin fins instead of the high horizontal surface and single fin as built (the final tail arrangement was selected in March 1938). The guns were housed in the nose in two pairs one above the other and the fuselage was very thin. The K.26, the ultimate development of Rolls-Royce's successful Kestrel, was later called the Peregrine and embraced some early Merlin features and experience. The original intention (in 1936) had been to practically redesign the Kestrel but, once the Westland prototype had been ordered, the need to fit it into the airframe meant that an all-new engine would not be ready in time; accordingly the K.26 became just a natural development of the Kestrel. A clean inline engine, the Peregrine greatly assisted the aerodynamics of the P.9 which was one of the most compact fighter designs yet proposed. The P.9's maximum rate of climb was 3,100ft/min (945m/min) and service ceiling 36,300ft (11,064m).

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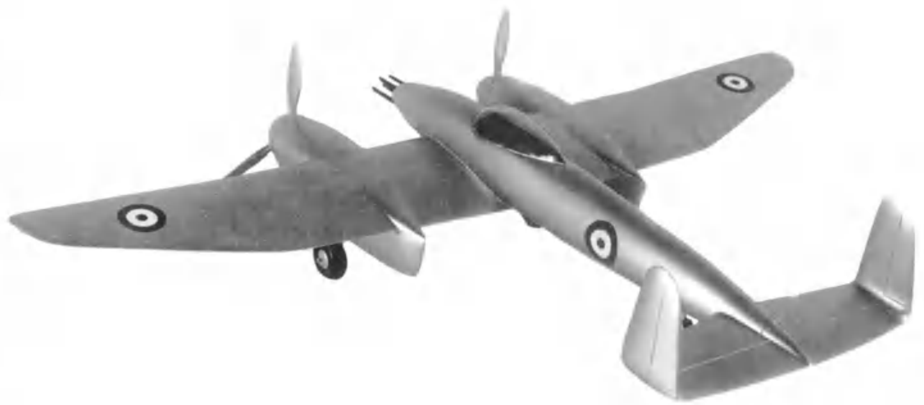
These designs were analysed at the Tender Design Conference held on 24th May 1936. Westland felt the chief advantage of a twin-engine layout was that the armament could be installed in the nose; if it was placed wide apart in the wings on a single-engined aircraft the gun's recoil would be uneven and result in inaccurate fire. Opponents said two engines would reduce manoeuvrability but the Conference commented favourably on the twin types submitted. It initially recommended the Supermarine 313, most experts' preference, because of Reginald Mitchell's recent success with the Spitfire and his experience in designing fast aeroplanes, but the type's delivery date (27 months) was considered excessive.

Westland's P.9 thus became the more favoured. DTD considered it the most advanced project while the company was not overburdened with work and another twin-engine type would provide a competitive stimulus to Supermarine. The P.9 represented a complete break from orthodox design and its novel features included a magnesium monocoque fuselage (a particularly innovative feature because its better strength-to-weight ratio enabled the skin to be thicker for the same weight than aluminium), a radiator in the wing leading edge to cut drag, integral wing fuel tanks that were detachable for maintenance, Fowler flaps for high lift but minimum wing area, large chord lifting slots and an internal exhaust.

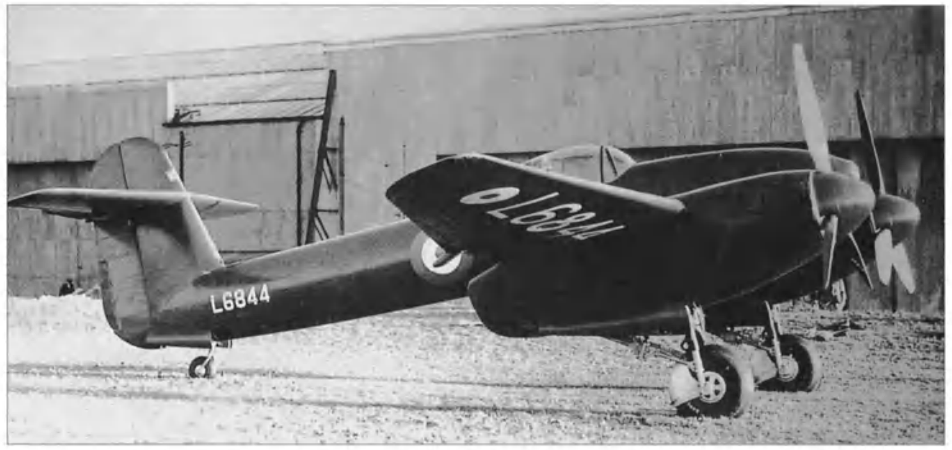
The idea of modifying either the Spitfire or Hurricane to take 20mm guns was rejected because their designer's drawing offices were too busy; it seemed quicker to order a totally new design from a less occupied company (later, during the war, both types were fitted with cannon). Because of the experimental nature of the armament the Air Ministry was anxious to order two P.9s, two P.88s and one Type 313. However, this exceeded the financial allocation and Treasury sanction had to be obtained for these prototypes. Treasury approval was given in January 1937 but only Westland's machine was built – the firm received a contract for two prototypes on 11th February and a maiden flight was expected in June 1938; a mock-up was examined on 28th May 1937.

Construction of the first prototype L6844 began in July 1937. However, following delays caused mainly by the new design features but also from hold-ups to the delivery of undercarriages and engines, its first flight did not come about until 11th October 1938. ACAS noted 'This fighter seemed a thoroughly practical and high-performance aeroplane and I only wish the production capacity of this firm were greater' – in fact there were proposals to move production to either Fairey or Hawker and because the P.9 was so experimental the Air Ministry would not risk ordering any production aeroplanes without flight trials.

A production order for 200 aircraft, to be called Whirlwind, was placed with Westland at the start of 1939. It was intended to build 800 more at Castle Bromwich but this plan

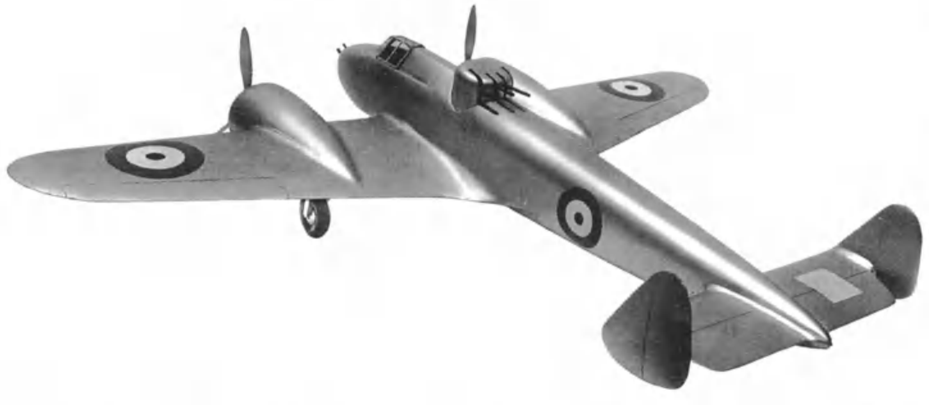


Model of the Westland P.9. FlyPast



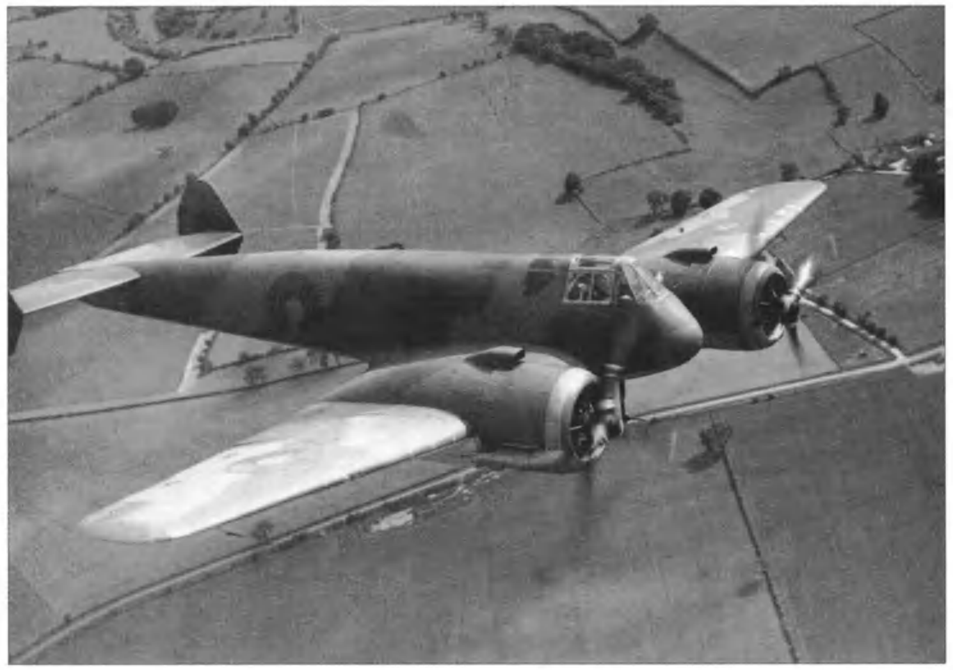
The first prototype Westland Whirlwind L6844. Fred Ballam, Westland

In early August 1941 Westland requested a 'good photographer' to take some pictures of the Whirlwind in flight before the production order was completed. This shot of P7110 taken in September was part of the results. Fred Ballam, Westland



Left: **Model of the Gloster F.34/35 turret fighter.** FlyPast

This page lower left and opposite page top: **Two views of L7999, the Taurus-powered Gloster G.39 to F.9/37.** Eric Morgan and Tim Kershaw (Jet Age Museum)



was replaced in March 1939 by Spitfires and 200 more Yeovil-built Whirlwinds. In the end, after development work on the Peregrine had been halted, only 114 Whirlwinds were built – the second batch was dropped and the original order reduced. Early in the war Rolls-Royce decided to abandon development of the Peregrine and concentrate its efforts on the Merlin, a move that curtailed the Whirlwind's career since the engine was not required for any other production aircraft type and its teething problems, though not severe, would never be fully addressed.

Some alternative powerplants were suggested. Roy Fedden at Bristol pressed strongly for the installation of two radial engines but Westland knew that fitting larger powerplants was impossible. The original concept had been to build the smallest possible fighter compatible with two engines and so its structure was neither roomy enough nor strong enough to take anything larger. Thus the Whirlwind was to be denied the prolonged RAF career enjoyed by the Hurricane and Spitfire and when it entered service in autumn 1940 the demand for more speed and height made it appear, at least in official eyes, to be verging on obsolescence. Nevertheless, by the end of that year it was clear that the Whirlwind was faster than a Spitfire Mk.I below 10,000ft, especially close to ground level, and just about equal to it between 10,000ft and 20,000ft (3,048m and 6,096m).

Gloster G.39

The first essay by Gloster for a twin-engine fighter was made to Specification F.5/33, work beginning in 1933 on a Bristol Aquila-powered turret-armed two-seater. In 1935 this scheme was brought up-to-date to meet F.34/35, the new design mounting a dorsal turret with more machine guns in the nose. Gloster had also prepared a project to F.9/35 (Chapter 3), which was satisfied by the Boulton Paul Defiant, but when the Defiant offered a performance that met both documents the Gloster F.34/35 was dropped, despite serial K8625 being allocated to a prototype ordered in 1935.

F.34/35 was replaced by another specification F.9/37, issued on 15th September 1937, which called for a fighter capable of at least 300mph (483km/h) at 15,000ft (4,572m). Two cockpits housed the pilot and an observer gunner, the pilot having a pair of 20mm cannon in the nose and the observer a retractable turret with a battery of four 0.303 (7.7mm) machine guns. Two Rolls-Royce Kestrel or Bristol Taurus engines were to be fitted. It is seems probable that Boulton Paul's two-seat P.89 design with twin modified Kestrel XVI engines and four 20mm cannon was also prepared to F.9/37, but no details survive.

In late autumn 1938 it was decided to delete the amidships cockpit and the Gloster G.39 project to F.9/37 was thus completed as a fixed-gun single-seat fighter. Two forward-firing 20mm Hispano cannon were placed beneath the pilot just forward of the rear spar and were inclined at a 'no-allowance' angle of 12° to the line of flight. In November 1938 a proposal was made to replace the turret with a battery of three more 20mm fixed at the same angle which were to be placed in the upper fuselage behind the pilot to fire forward over the cockpit hooding; they presented a potentially formidable armament and the fuselage would be bulged to accommodate the extra guns and allow them to fire clear of the cockpit. The idea was accepted but photographic evidence suggests that the rear guns were never fitted to either prototype, although both did carry their nose guns.

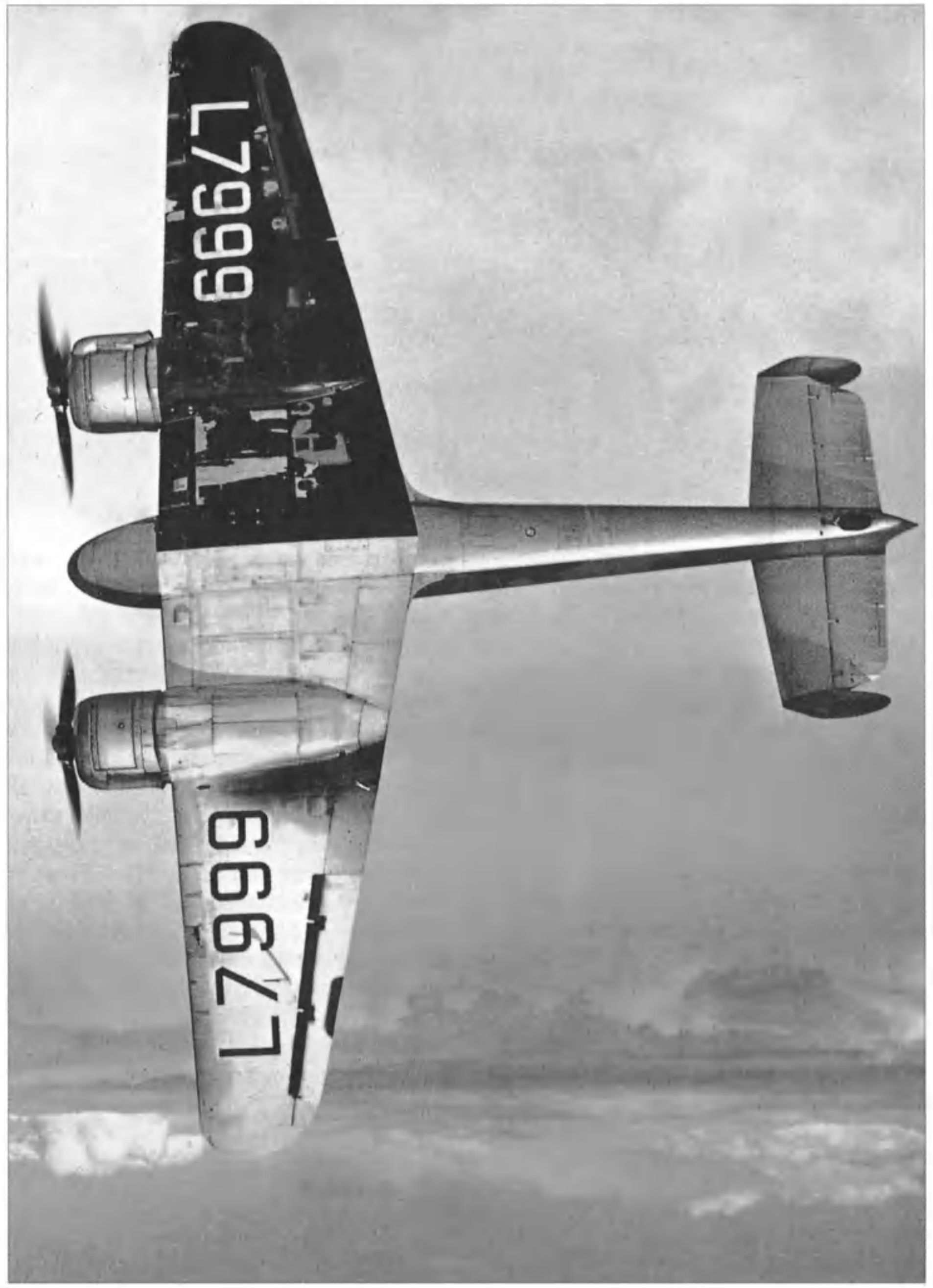
Two G.39 prototypes, serials L7999 and L8002, were ordered but circumstances dictated that they received different powerplants. The first had two Taurus air-cooled radials while L8002 had liquid-cooled Rolls-Royce Peregrines and chin radiators. Construction of L7999 began in the Gloster Experimental Department at Hucclecote during February 1938 and the first flight was made on 3rd April 1939. Early flights demonstrated performance and handling that suggested great potential and the F.9/37 reached speeds in excess of 360mph (579km/h). The second aircraft with the less powerful Peregrines had a top speed of 330mph (531km/h) but both machines proved remarkably manoeuvrable and docile and could be rolled and looped in comfort.

There were further proposed developments to F.18/37 (Chapter 1) and F.11/37 and F.18/40 (both Chapter 3) but no variant of the G.39 was to receive a production contract. The F.9/37 had much in common with the Westland Whirlwind in that it was built by a firm with no previous hardware experience of high-performance twin-engine fighters and made use of engines which gave problems because they were not fully developed; neither aircraft was big enough to take a larger engine. When Lord Beaverbrook, the head of the new Ministry of Aircraft Production, announced in mid-1940 an emergency production programme of only three bomber and two fighter types, the F.9/37 was not one of them. Later, when the situation had improved, types such as the Mosquito had taken the state of the art beyond that offered by Gloster's twin.

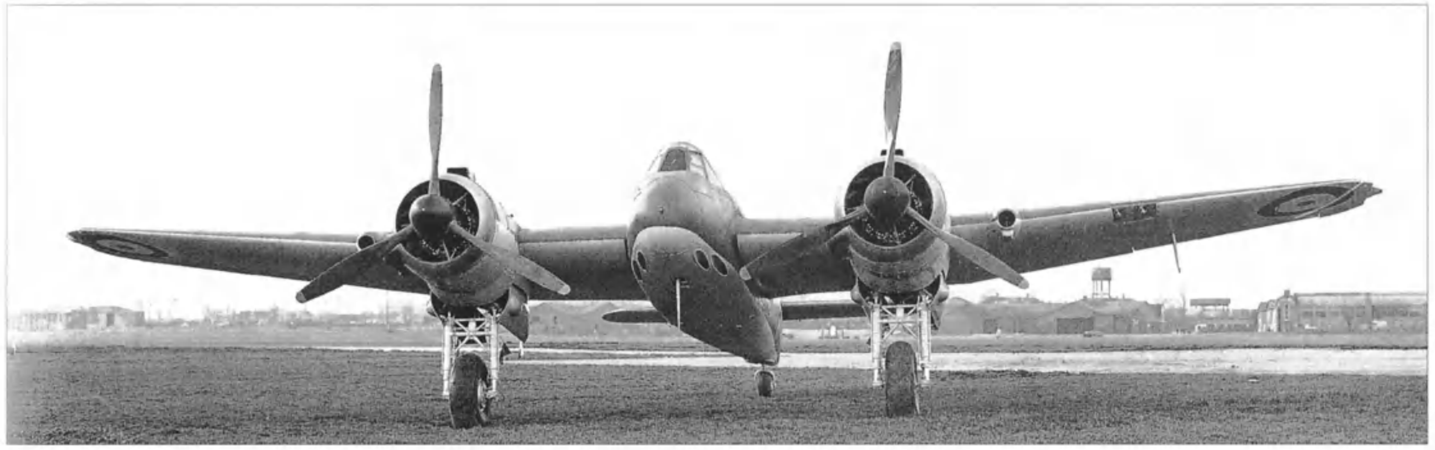
Bristol Beaufighter

As has already been noted, well before the war began the Air Staff had been keen to obtain a cannon-armed fighter. The highly experimental Whirlwind's development was slow and by autumn 1938 the Air Staff was faced with the possibility that a suitable aircraft might not be available for some time. ACAS, Sholto Douglas, was anxious to find an aircraft that could be produced as a cannon fighter as soon as possible.

It was too late to begin an all-new type with its inevitable prolonged period of development so when Bristol Aircraft submitted a proposal to convert its Beaufort torpedo



This view shows how compact and neat the Bristol Beaufighter was, this example having Hercules engines.



Merlin-powered Beaufighter Mk.IIF T3019 at Filton in 1940. The AI Mk.IV nose radar aerials are visible and the aircraft is painted matt black. David Charlton

bomber, the Air Staff reacted favourably. Leslie Frise reported that the Beaufort's wings had proved to be very strong which suggested that they might be suitable for a fighter with more powerful engines and higher speeds. Bristol originally proposed mounting two 20mm Hispanos in a turret but the firm also submitted an alternative with four fixed Hispanos and Sholto Douglas felt this second scheme was the better of the two.

Since the Beaufort combined the functions of torpedo bomber and general reconnaissance aircraft it did not possess an outstanding performance but Bristol intended to improve this by substituting its Taurus engines for the new Hercules. Early estimates for the fighter conversion quoted a speed of 370mph (595km/h) but the main objective was to use as many standard Beaufort parts as possible; the fuselage body, however, would be smaller with an all-new forward section.

Bristol intended to take a partially completed Beaufort off the production line and convert it into a fighter prototype while production aircraft ordered off the drawing board would enter manufacture at the same time. In this way a competitive tender and a separate prototype stage would be avoided. The company's promise that if an immediate order was placed production would be under way in early 1940 persuaded the Air Council Committee on Supply to accept the new project and proceed immediately with 300 aeroplanes, a move agreed on 24th February 1939. The mock-up was examined on 17th April and in July the draft specification F.17/39, which did not play its usual part in determining the design's limits, was finally approved. F.17/39 described the Beaufighter as an interim type to precede the Whirlwind with a speed at 15,000ft (4,572m) of not less than 350mph (563km/h).

Beaufighter Mk.I R2156 flies over a wintry English landscape while serving with 252 Squadron, probably in early 1941.

In the event two converted Beauforts were ordered together with two new build prototypes. The aircraft was known as the Type 156 Bristol Cannon Fighter or Beau Fighter, which eventually became its official name. Construction of the converted Beauforts began immediately but the smooth progress of both prototype and production was soon interrupted. It had been expected that the Beaufort fuselage could be converted with little trouble but the layout of the cannon fighter was so different from a torpedo bomber that eventually the whole fuselage had to be redesigned and the extra drawing office time that this needed delayed construction. Prototype R2052 finally flew on 17th July 1939. Fitted with Hercules I-SM units, in clean condition it achieved the estimated top speed of 335mph (539km/h) at 16,800ft (5,121m); however, when R2054 with Hercules IIIs and full operational equipment began acceptance trials at Boscombe Down in June 1940 it could only make 309mph (497km/h) at 15,000ft (4,572m).

The outbreak of war resulted in large orders for Beaufighters but a potential shortage of Hercules engines was worrying. Consequently a Rolls-Royce Merlin variant was thought to be the most effective solution and on the 17th February 1940 Sir Wilfrid Freeman arranged for three aeroplanes to be converted. He hoped to clear the Merlin variant, which was estimated to have a similar performance to the Hercules III, in July with production following in early 1941 and the move was supported by Sholto Douglas who felt this would be a wise insurance. The Merlin powerplant had been developed for the Avro Lancaster bomber's outboard positions and it was adapted for the Beaufighter with an intermediate section to fit the aircraft's nacelle. The first Merlin Beaufighter, R2058, first flew on 14th June 1940.

The Beaufighter was successfully developed for a number of roles but possibly its most significant achievement was to become Britain's first practical radar-equipped night fighter. In late 1940 the Luftwaffe's heavy night bombing Blitz brought with it a most urgent need for a night fighter. The first British aircraft to attempt to fill this role had been the Bristol Blenheim Mk.IF but its lack of performance and poor radar ensured that this was only a stopgap. The Hercules-Beaufighter Mk.IF was the first effective RAF night fighter because it backed its radar with a powerful armament and a performance that enabled it to catch most Luftwaffe bombers. The Merlin Beaufighter served primarily as the Mk.IIF night fighter but its main weakness was that the speeds obtained during early flight tests, which had led to strong hopes of an improved performance over the Mk.I, were not repeated. From an aerodynamic point of view the Mk.II was never satisfactory.

In early January 1939 Bristol proposed its Type 157 three-seat Hercules-powered bomber variant and also a slim fuselage 'sports-model' called Type 158. The bomber conversion was known as the Beaubomber and formed part of the events leading to the Type 163 Buckingham (Chapter 5). In August 1940 it was agreed that the Type 158 with Hercules IIIs should be the Beaufighter Mk.III and with Merlin XXs the Mk.IV. However, producing the new slim fuselage would take many months and, if new jigs and tools were required, could stretch to a year.

The Assistant Chief of the Air Staff (Technical), ACAS(T) R S Sorley, hoped that the work would receive high priority because the new fuselage was expected to increase the top speed by 8mph to 10mph (13km/h and 16km/h). Some Air Staff members felt a 10mph increase did not justify the required jigging and tooling but DTD pointed out that 10mph at 300mph (483km/h) was a considerable increase. The Mk.III would have six 20mm cannon and eight Browning machine guns and was expected to fly at the end of 1940 but work was eventually halted by the Battle of Britain. On 1st April 1941 the Ministry confirmed that work was unlikely to restart in the near future and the type was never completed.

The Mk.V designation went to two Merlin Beaufighters which had no wing guns but instead a dorsal turret with four 0.303in (7.7mm) machine guns. Fighter Command had an urgent need for a turret version but the conversion took time. One example, R2274, was tested at A&AEE around early summer 1941 and the turret was found to operate satisfactorily even in dives up to 390mph (628km/h). The aircraft weighed 18,695lb (8,480kg) and with the turret facing aft gave a top speed of 302mph (486km/h) at 19,300ft (5,883m).

On 5th January 1942 Frise suggested to Air Marshal F J Linnell, CRD, the idea of a Torpedo Beaufighter with external torpedo carriage keeping the required modifications as simple as possible. Linnell examined the proposal on 11th February and noted that its 'virtues were outweighed by its vices – the approach speed was too high for torpedo dropping and the longitudinal stability was not good enough for torpedo work', so he turned the idea down. Bristol responded with a more detailed approach which was more favourably received. After testing Coastal Command found that it liked the type as a combined torpedo/fighter – it was really the only aircraft that could be so converted, the adaptation of the Handley Page Hampden to this role having been a failure. A memo by Sorley dated 9th September 1942 revealed how enthusiastic he was to re-equip with the type and the torpedo Beaufighter became the Mk.X. The Beaufighter proved to be a very successful wartime aircraft and nearly 6,000 were eventually built.

De Havilland Mosquito

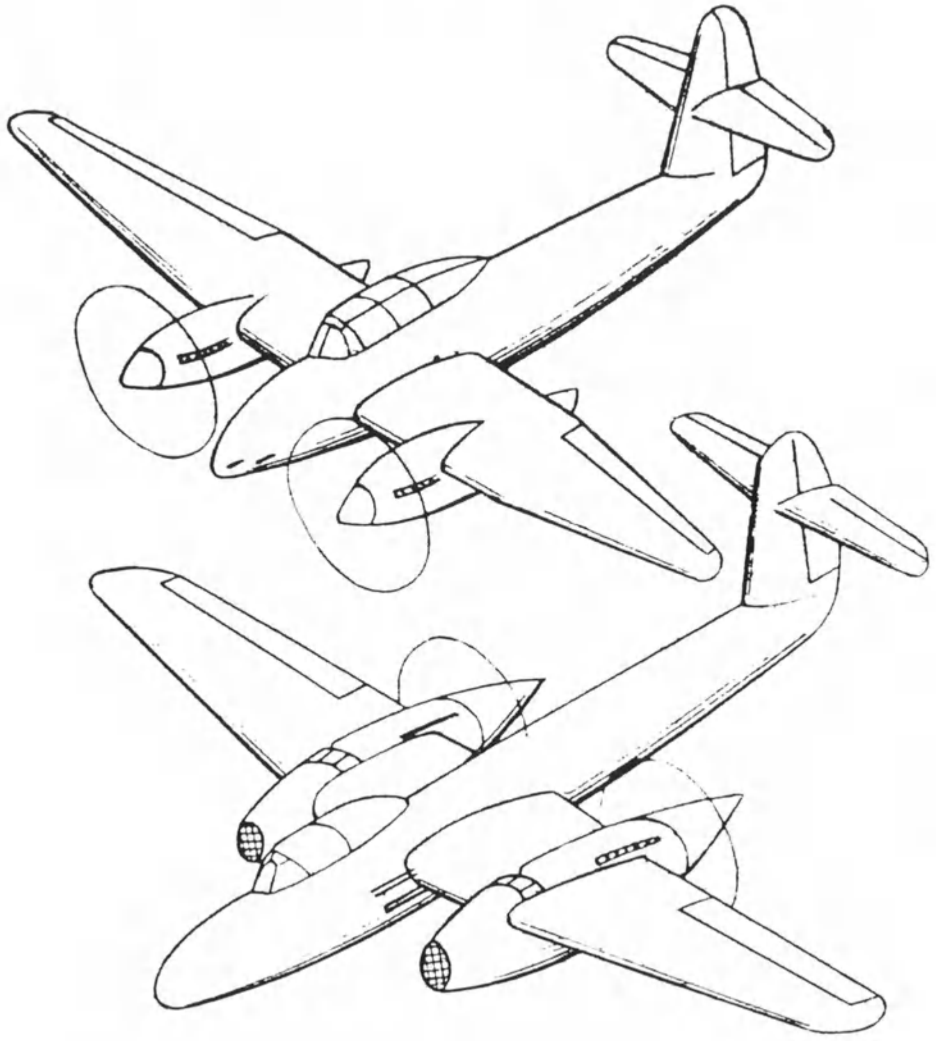
The de Havilland Mosquito was first designed as a light unarmed bomber before being developed as a fighter and full multi-role aircraft. The Mosquito story, including the fighter variant, is described in Chapter 5.

Specification F.6/39
Vickers Type 432

The Type 432 was the last Vickers fighter to reach manufacture and flight test. Only two airframes were built and just one was completed which flew a mere 29 times, yet the full story stretches from spring 1939 until late 1945. Specification F.6/39 was issued in March 1939 for a two-seat fighter with high speed (minimum 400mph [644km/h]). It would carry four 20mm guns, with the possible later installation of two 40mm weapons, and the following projects were proposed.

The Mosquito fighter carried the formidable armament of four 0.303in (7.7mm) machine guns in the nose and four 20mm cannon in the lower fuselage. This shot was taken in September 1943. Barry Guess, BAE Systems, Farnborough

DD750 was a Mosquito night fighter NF Mk.II. Phil Butler



The only known illustrations of Westland's fighter projects to F.6/39 (both 5.39). Fred Ballam, Westland

Fairey F.6/39

No details are known about this project.

Supermarine 334

Sadly this too is an unknown project, one of the few wartime Supermarine designs that do not appear to have survived. It is believed that a mock-up of the 334 was built.

Westland F.6/39

This covered two projects developed from the Whirlwind and powered by Rolls-Royce Griffon engines, one with conventional tractor powerplant (there was also a version with Merlins), the other with pusher engines. The latter had radiators in the front of the engine nacelles and a tricycle undercarriage.

F.6/39 was soon overtaken by new requirements and these projects were abandoned. However, work continued at Vickers.

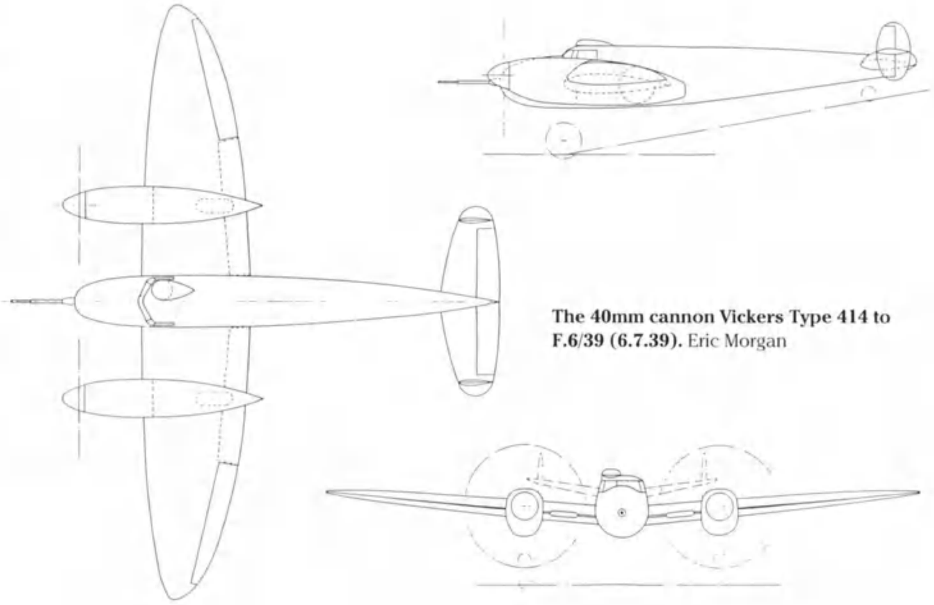
Vickers 414

The design team led by Rex Pierson had been working on a proposal for a Griffon-powered fighter with a single movable 40mm gun and on 19th April Pierson and Vickers' Mr. Dunbar met Sir Wilfrid Freeman, the then Air Member for Development at the Air Ministry, to ask that their two-seat project should be continued. The powerful Vickers cannon was mounted in the extreme nose and could be elevated 45°, depressed 10° and trained 15° to either side. The range-finding sight with predictor fire control was operated by a gunner/loader seated alongside the pilot and the whole installation was based on the theory of accurate single-shot firing. If the gunner kept the sight on the target, the predictor would automatically keep the gun pointing at it. No other weapons were to be carried.

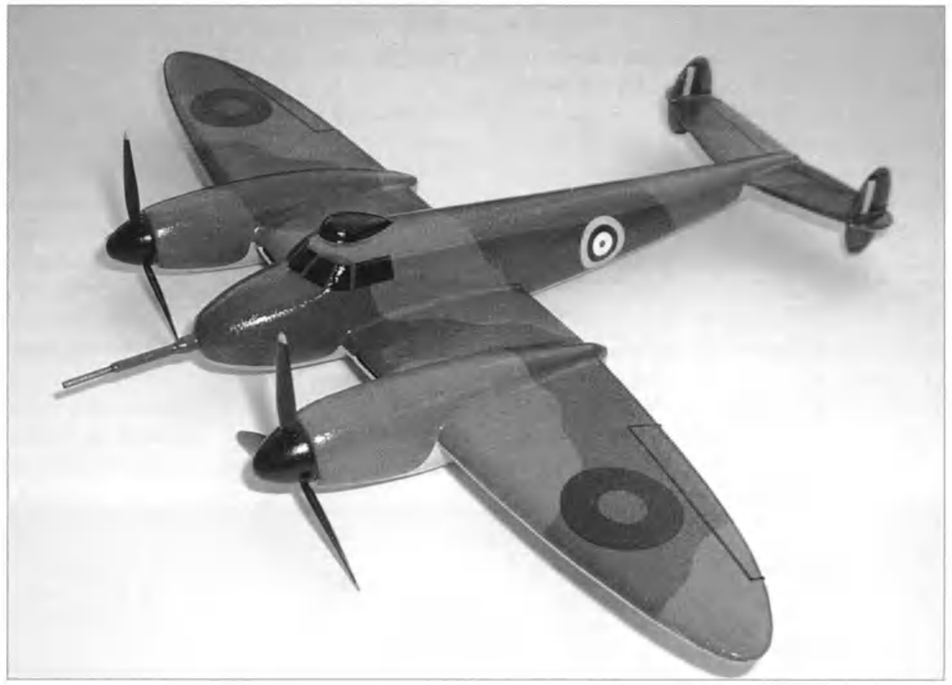
The aircraft, which became the Type 414, was to be all-metal and carried 210gal (955lit) of fuel. Top speed when fitted with forward facing intakes would be 439mph (707km/h) at 19,500ft (5,944m) and maximum rate of climb 4,560ft/min (1,390m/min) at 1,000ft (305m); top speed without forward facing intakes was 413mph (665km/h) at 15,000ft (4,572m). A draft scheme was tabled in June 1939 which, following discussions with the Ministry, was formally submitted soon afterwards. A simultaneous effort was made to design a fixed-gun aircraft to F.6/39. Calculations were completed on the 22nd June for two versions of the fixed-gun fighter with either tractor engines or pushers and on 6th July a brochure was prepared which mainly covered the single 40mm with predictor but also included the other designs. The Ministry expressed great interest in the movable 40mm version and in autumn 1939 Specification F.22/39 was quickly prepared to cover the project. On 1st November Vickers was told that F.6/39 had been deleted from the 1939 programme.

F.22/39 requested a 40mm cannon fighter with a top speed at 20,000ft (6,096m) of not less than 400mph (644km/h). The predictor gunsight was to be operable in the height band 500ft (152m) to 25,000ft (7,620m) at ranges between 200 and 1,000 yards (183m and 914m). The primary object of F.22/39 was to obtain an aircraft that would test the principle of the heavy calibre gun and its predictor sight and a contract for two prototypes, serials R4236 and R4237, was placed on 30th August 1939. The 40mm gun and its sight were tested in a dorsal turret fitted on Wellington L4250. It first flew with the turret on 25th October 1940 and fired its first shots at a target (towed by a Hawker Henley) on 8th November – no hits were achieved but it was estimated that 50% of the shells came within 4ft (1.2m) of their objective.

The 414's Mock-up Conference was held on 1st February 1940 but then the Air Ministry's Wing Commander H Rowley inquired about the likelihood of fitting 20mm Hispano guns in lieu of the 40mm. On 15th April Pierson produced in response a supplementary brochure to F.22/39 with alternate armaments of eight 20mm or two 40mm. The main external difference was a longer, slimmer

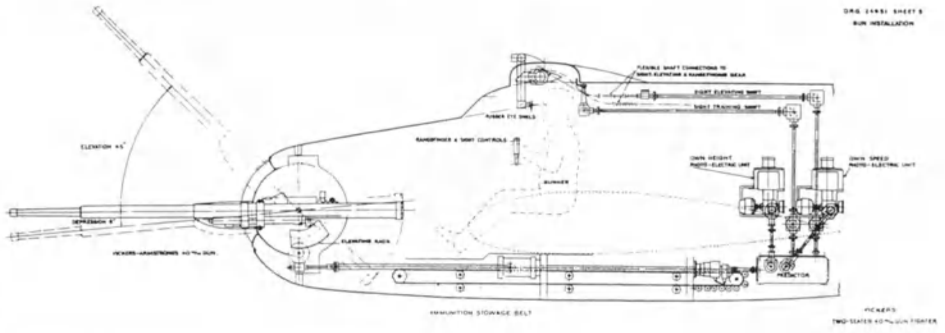


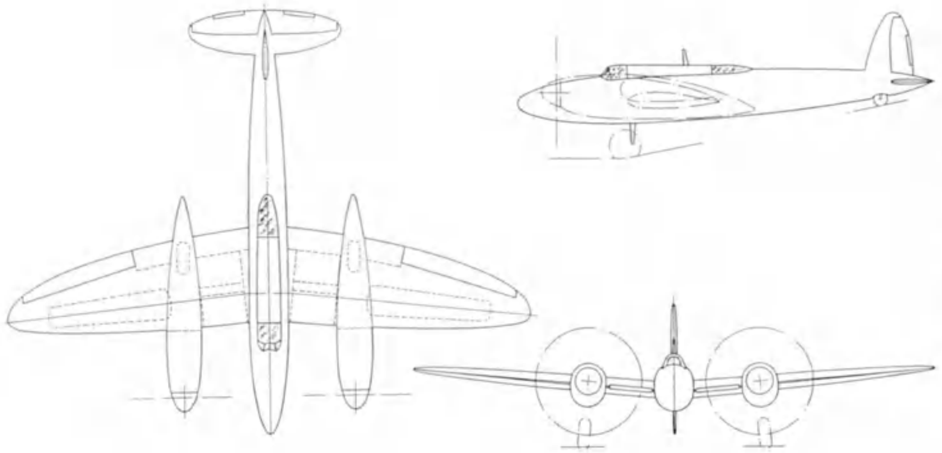
The 40mm cannon Vickers Type 414 to F.6/39 (6.7.39). Eric Morgan



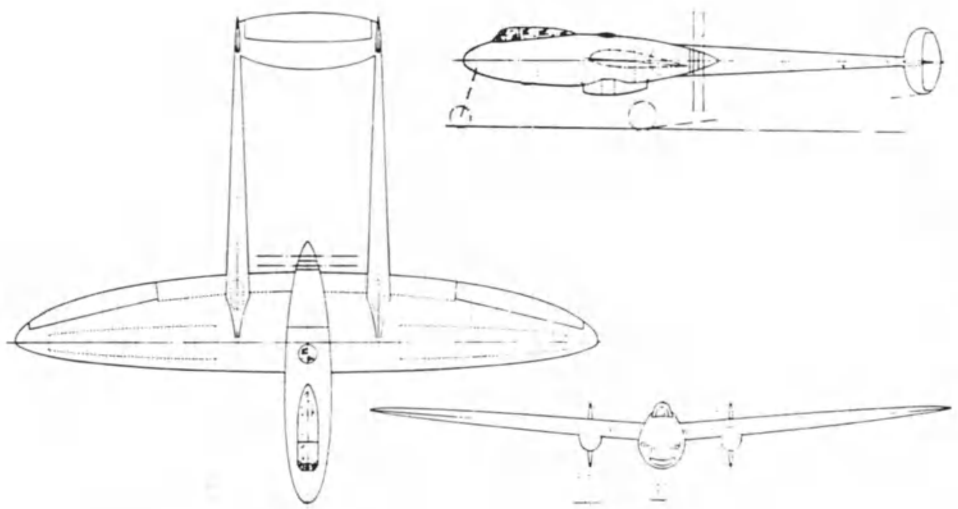
Above: **Model of the Vickers 414.** Joe Cherrie

Below: **The Type 414's 40mm cannon installation and cockpit.** Eric Morgan

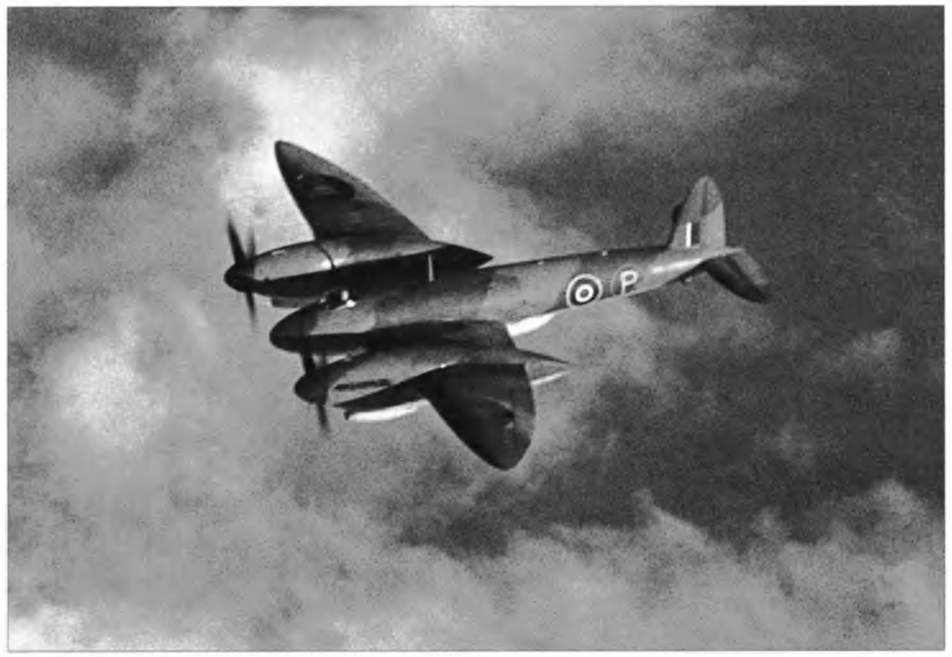




The two-seat 20mm gun Vickers 420 to F.16/40 (1.1.41). Eric Morgan



Unnumbered project for a Vickers twin-boom three-seat night fighter with six 20mm cannon (27.8.41). This was to be powered by a single Napier Sabre NS.3SM, span about 60ft (18.3m) and length 50ft (15.2m) but no performance data is available. Eric Morgan



The Vickers 432 prototype DZ217 shows off its unique wing shape high above the clouds. One test flight, made on 11th November 1943, was partially devoted to photography and, hence, this is the most likely date for one of very few views of the aircraft in flight. Eric Morgan

cockpit because the second crewman no longer sat alongside the pilot but instead behind him facing rearwards. On the 20mm version two guns protruded from the nose while sets of three were stacked either side of the pilot, on the 40mm variant the guns were also now placed to each side of the cockpit rather than in a nose turret. The powerplant was still two Griffon RG.2SMs.

Vickers 420

Discussions regarding the proposed 20mm cannon fighter were held in June 1940 and resulted in a new specification, F.16/40, which was given very high priority. The design was called the Type 420 and Pierson reported on 19th November that 'we are to build two F.22/39 Fighter Machines, also two F.16/40 Fighter Machines and the 16/40 will be urged ahead of the 22/39. In view of this the existing contract for 22/39 will presumably stand and I anticipate a further contract for the 16/40 machines'. F.16/40 stated that the design was to be basically that of the aeroplane constructed to F.22/39 and it was intended that the new requirements should be met with the minimum amount of additional work. The performance figures were identical to F.22/39 and a new brochure was prepared on 12th October to cover F.16/40 which showed for the first time a single fin and rudder. In January 1941 the armament was cut to six 20mm and the protruding nose guns were taken out. Similar projects with Merlin engines were proposed to the F.18/40 night fighter requirement (Chapter 3).

Vickers 432

On 17th January 1941 Pierson completed a brochure for a two-seat high-altitude fighter with four 20mm Hispanos and two Merlin XXII which utilised all of the components then being designed for the F.22/39, including the fuselage which, being of circular cross-section and stressed skin construction, could easily be made into a pressure-cabin. Eventually there were two layouts – 'A' developed out of the Type 420 and 'B' (dated 7th February) with a larger span of 63ft (19m) to improve the ceiling.

On 5th March Pierson told Major Kilner that, following conversations with Sir Henry Tizard, Mr Farren and Mr Westbrook, 'it would appear likely that the Air Ministry will place an order with us for two experimental High Altitude Fighters based on our F.22/39 design'. Work on the Type 414 was stopped and discussions with Rolls-Royce now turned in earnest to fitting Merlins instead of Griffons. By the end of March the design had advanced with a span set at 56ft 10.5ins (17.3m) as a compromise between A and B. On 13th May the first brochure was submitted for the single-seat high-altitude fighter which was to become the Type 432. The pressure cabin was 16.5ft (5m) long by 4.5ft (1.4m) diameter and comprised the forward portion of the fuselage back to and including the rear wing frame. In order to obtain the best possible fighting view the pilot had been moved to the extreme nose and was covered by a hinged dome together with a bullet proof protecting visor. Six 20mm Hispanos were housed in an underbelly fairing.

N E Rowe, DTD, discussed the single-seat fighter with Barnes Wallis and was much impressed by it. Vickers received a contract on 9th September 1941 for two prototypes, DZ217 and DZ223 to be built to a new specification F.7/41, and was told that it was important for the company to make the greatest possible use of the design data, materials and parts prepared, purchased or manufactured for the two aircraft ordered to F.22/39 and now cancelled. F.22/39 was actually stopped in May 1941 and one reason for this was that, despite being a fast aircraft, its weight was likely to prevent it from being sufficiently manoeuvrable to meet smaller enemy single and two-seat fighters. Moreover it appeared to have insufficient endurance for night fighter use and so the Air Staff decided there was no requirement for it.

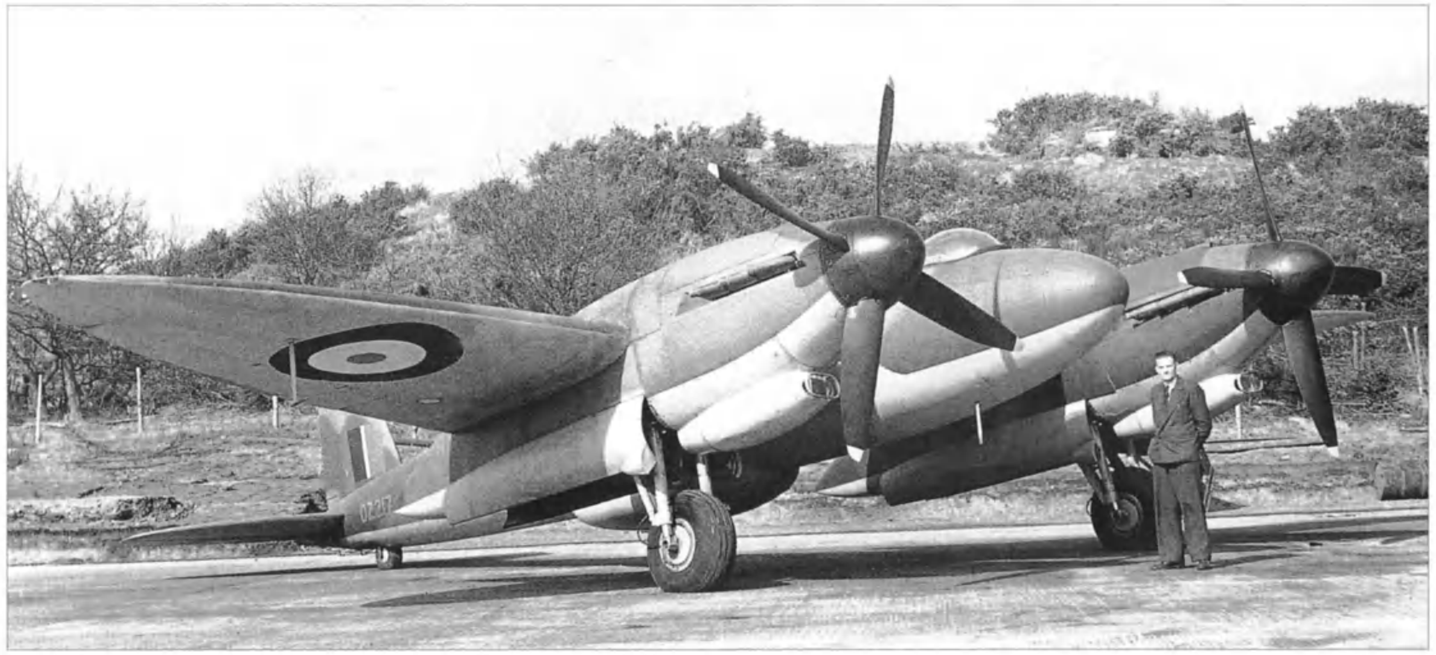
A reference in F.7/41 to diving speed highlighted a growing problem in new high-speed aircraft, that of compressibility and its affect on the loading of the fuselage, wing and tailplane of fighters. For fighters, the capability to dive on their targets without restriction was vital and Pierson and Wallis were visited by Rowe on 17th March 1942 to discuss the maximum stressing speed of the 432. It was pointed out that the design of present-day fighters was based on the limiting diving speed of 450mph (724km/h), compressibility effects being neglected.

However the introduction of high-altitude fighters capable of entering a dive from heights far greater than had been possible in the past might lead to the attainment of diving speeds greater than the arbitrary limit hitherto assumed. Wallis stated that calculations had shown the maximum velocity of a dive, if indefinitely continued, occurred at a height approximately 10,000ft (3,048m) above ground level, prolongation of the dive below this height resulting in a slight diminution of speed. It therefore seemed desirable that 10,000ft (3,048m) should be chosen as the height at which the design loads should be calculated and on the strength of this, and some other factors including the drag curve, Rowe decided that the limiting speed to be taken for stressing this fighter should be 500mph (805km/h) with compressibility effects now taken into account.

A few days later some independent calculations made by RAE suggested that the F.7/41 could reach 550mph (885km/h) in the dive if it was started at 43,500ft (13,259m) with a horizontal speed of 320mph (515km/h). The angle of dive, provided it was greater than 60° to the horizontal, appeared to have little effect on the ultimate speed but the question of airscrew drag at very high speeds was still being investigated by RAE. However the 500mph (805km/h) limit in F.7/41 was not changed since it was felt that to exceed this figure in the 432 would be dangerous anyway due the lack of sufficient reserve strength.

The 432's Mock-up Conference took place on 30th December 1941 and the prototypes were built during 1942. First flight was delayed for a number of reasons but DZ217 finally climbed into the air on 24th December 1942. Five days later MAP advised that only one prototype was to be completed and all work on the second machine was cancelled, although the official confirmation of this decision did not arrive until May 1943. The maximum level speed actually achieved by DZ217, in May 1943 at an all-up-weight of 17,700lb (8,029kg), was 380mph (612km/h) at 15,000ft (4,572m) some way off the design estimate of 435mph (700km/h) at 28,000ft (8,534m); however, 400mph (644km/h) was exceeded in a dive.

DZ217 seen shortly after completion. Eric Morgan



The final flights were made in November 1944 and was never submitted for official trials; DZ217 was eventually scrapped. The Type 432 and its ancestors initially showed undoubted promise but the long period of time taken to produce hardware allowed this to evaporate and no real effort was ever made to correct the aircraft's faults. Consequently, it will never be known just how good this aircraft might have been. Vickers' own war diary describes the 432 as 'an interesting experiment which resulted in a dead end'.

Specification F.4/40 Westland Welkin

By 1940 the Air Staff had a strong wish to acquire a high-altitude fighter. During the late 1930s increasing effort had been put into the development of high-altitude aeroplanes fitted with pressure cabins and, indeed, the Experimental Aircraft Programme for 1937 had included a specification, B.25/37, for a four-engined bomber with a pressure cabin (it was assumed that if a UK pressure cabin bomber became a reality then so would a German). That requirement, however, was not proceeded with but General Aircraft began working on a pressure cabin variant of its Monospar airliner and in October 1939, after the Air Staff had asked that a high-altitude fighter should be developed, the company submitted a brochure for a fighter.

General Aircraft GAL.46

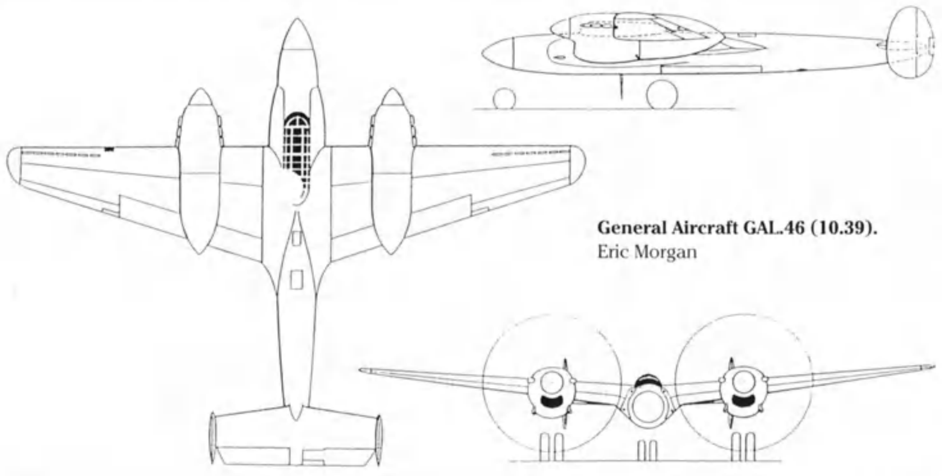
General observed that sooner or later the defences against air attack at 'low level' will become difficult to penetrate and so enemy aircraft would then have to make use of the stratosphere. Hence there was an urgent necessity to prevent the enemy enjoying immunity of operation at high altitudes while it was also desirable that Britain's own forces should enjoy the operational benefits of stratospheric aircraft. The brochure noted that 'the attainment of such heights is now well within the bounds of scientific and practical possibility' and added, after studying various patents, 'that the enemy is well advanced in its thoughts along these lines.'

General acknowledged that the development of pressure cabin aircraft in Britain was not very advanced but the fact that there was one pressurised aircraft ready to start flight testing (the Monospar) was 'due solely to the initiative of this company which, entirely at its own expense, has been engaged on this research for the last two years.' This pressure cabin research aircraft had emerged from a long series of static and blower plant tests and General now wanted to apply its knowledge and experience to a military application. The suggested twin-engined design was based on the requirements of F.6/39 and could not only perform the duties of a cannon fighter up to the highest possible level but also carry out long-range bombing and long-range high-altitude reconnaissance and photography. The company observed that once the principle of the pressure cabin had been accepted the attainable ceiling was a mainly a matter of engine design and this opened up a somewhat neglected avenue of engine supercharger development. Engines would be required with either multi-stage blowers or, better still, exhaust turbo-blowers.

However, for the time being whilst such equipment was being developed, the GAL.46 would use standard Merlins which still allowed the crew to reach high altitudes in comfort when, at present, they could only reach them by great physical endurance and by using oxygen (oxygen made crews very tired which reduced patrol times). Due to its speed and ability to fly high, the GAL.46 dispensed with any form of turret equipment (although two cannon could be reversed in their mountings to provide rear defence). It had two crew, four 20mm cannon (two on each side of the fuselage) and carried 190gal (864lit) of internal fuel. At its best operating height it could reach 395mph (636km/h) while estimated rates of climb were 2,940ft/min (896m/min) at sea level and 3,185ft/min 971m/min) at 9,000ft (2,743m). The aircraft would take 7.1 minutes to reach 20,000ft (6,096m) and 14.0 minutes to achieve 30,000ft (9,144m), service ceiling was 37,200ft (11,339m). As a bomber it could carry four 500lb (227kg) bombs under the wing roots (ceiling 29,800ft [9,083m]) while reconnaissance sorties could be made at 35,000ft (10,668m) and 2,250 miles (3,620km) range. General described its project as 'an extremely formidable weapon'.

The GAL.46 was expected to use simple construction and a tricycle undercarriage, another area in which General had more experience than any other British constructor because in 1938 it had flown a Monospar with a tricycle undercarriage. Composite construction would be used where possible but a metal centre section and outer wing would be necessary because of the pressure cabin, high load factors and the need for great rigidity. Future research would embrace the need to keep the structure, windscreen and petrol systems, and so on, free of ice, plus the development of the blower system on the engines. The brochure's altitude figures, based on standard Merlins, would be much improved by such developments.

On 1st November ACAS and DGRD agreed to proceed with the GAL.46 as a 'development' to gain experience. However, the desirability of placing an order for it was discussed again on 18th April 1940 by AVM Hill (DTD), Air Commodore Saundby (the Director of Operational Requirements, DOR), Capt Liptrot, Messrs Farren, Grinstead and others. The Air Staff had for some time stated that high-altitude fighters were important and its wish to develop them was strong. It was agreed that an aircraft capable of use up to 45,000ft (13,716m) should be designed now in readiness for a suitable powerplant for that height, but General Aircraft's lack of experience in fighter design caused doubts as to whether it could produce a useful aircraft. The company's work on pressure cabins did not inspire great confidence in its ability to deal unaided with the problems of design, although help would be forthcoming from RAE. It was agreed that some other firms should therefore be asked to tender for the design and construction of a pressure cabin fighter and, provided General revised its design on satisfactory lines, it should be one of two companies to receive orders for experimental aircraft.



General Aircraft GAL.46 (10.39). Eric Morgan

Fairey, Hawker, Vickers-Armstrongs and Westland were invited to tender and in July Specification F.4/40 was raised to cover the new type. A top speed of at least 400mph (644km/h) was requested consistent with a high service ceiling while the pressure cabin would have to maintain conditions appropriate to 25,000ft (7,620m) when the fighter was flying above that height up to 45,000ft (13,716m). The tenders were as follows:

Hawker P.1004

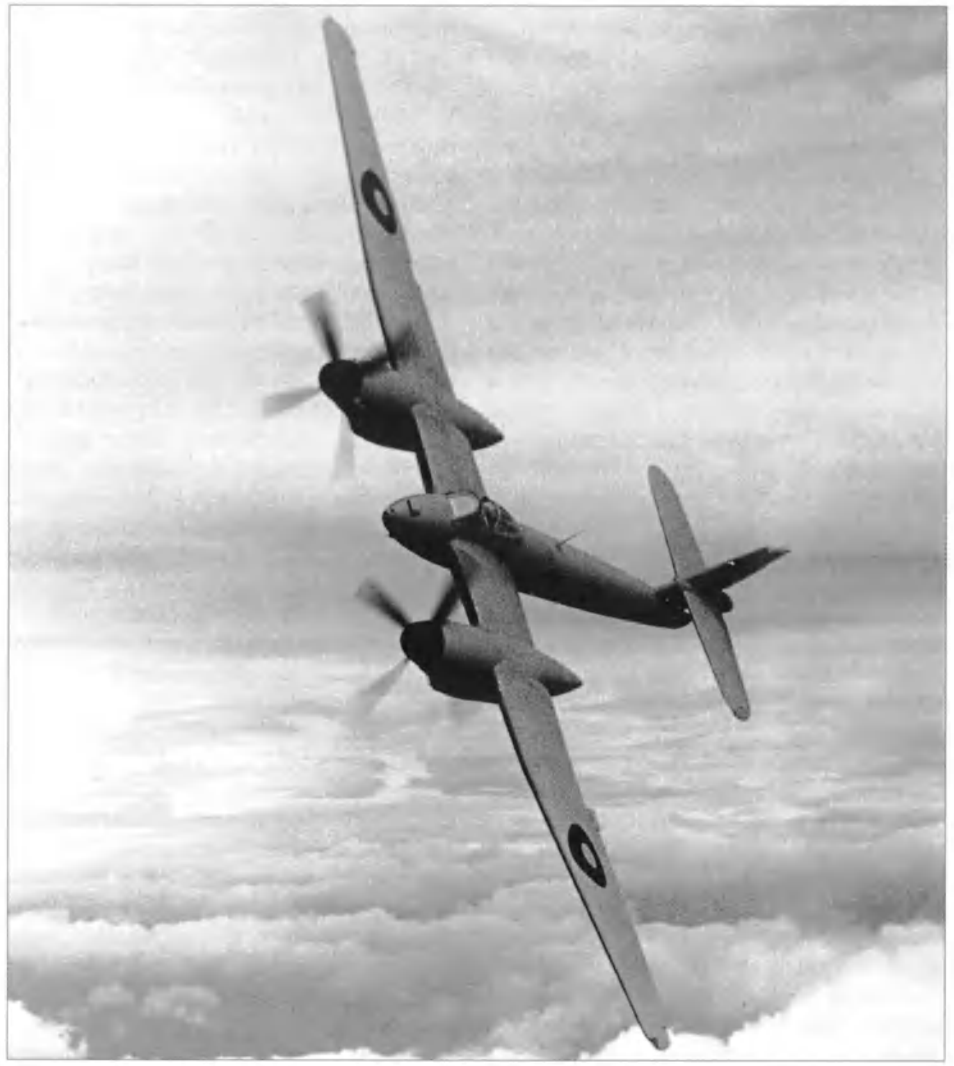
This two-seat fighter with a single Napier Sabre was virtually a development of the Hawker Typhoon and shared the same aerodynamic and structural features. No drawing is known to survive but its design and construction followed the Typhoon's very closely and the project was in fact a Typhoon scaled up by 25% plus the addition of the pressure cabin and the second crewman seated with his back to the pilot. For this reason the required development work was expected to be much reduced with no wind tunnel testing required. The two mainplanes were attached direct to the centre fuselage, which dispensed with a complicated centre plane, and there were 238gal (1,082lit) of internal fuel. Rate of climb at sea level was 2,250ft/min (686m/min), time to 25,000ft (7,620m) 13.4 minutes and service ceiling 37,000ft (11,278m).

General Aircraft GAL.46

The original project revised with 1,170hp (872kW) Merlin XXs and six 20mm cannon.

Westland P.13

Westland submitted two proposals. The first was a highly experimental arrangement of typical single-engined layout but in which two Merlin XXs in the nose were coupled in tandem to drive a pair of contra-rotating airscrews through a common gearbox. It carried six 20mm cannon, three in each wing, but was disliked by the Air Staff, partly because of the very poor view for the pilot and also due to some questionable handling qualities for fighting. Time to 20,000ft (6,096m) was estimated to be 9.3 minutes and to 30,000ft (9,144m) 16.2 minutes, service ceiling 37,000ft (11,278m). It does not appear to have been examined in detail and no drawing has been found. Both Westland designs had the second crewman sitting with his back to the pilot.



Model of the GAL.46. Eric Morgan

Westland Welkin DX318. Fred Ballam, Westland

Westland P.14

This was a twin-Merlin project which followed the same general aerodynamic and structural lines of the Whirlwind. It used flat plate webs in the construction of the spars and the two-spar booms were formed by diagonally cutting a single extrusion. Four of the 20mm were housed in the fuselage, the other pair in the wing centre section. Internal fuel 360gal (1,637lit), sea level rate of climb 1,600ft/min (488m/min), time to 25,000ft (7,620m) 13.5 minutes and service ceiling 36,500ft (11,125m).

These proposals were much discussed. The GAL.46 brochure was criticised for giving too little structural detail and since the company had not yet built anything larger than a trainer, there was no background on which to guess its structure. It was considered that the tender gave insufficient information to assess its worth and the project's handling qualities as a fighter were mistrusted, while the long nose spoilt the pilot's view. The company itself had made a laudable pioneer effort in pressure cabin construction but new enquiries into its work on the pressure cabin Monospar revealed that little serious work had been done in dealing with the main problems.

An F.4/40 Tender Design Conference was held on 17th October 1940. DTD, then W S Farren, opened it by pointing out that the research and development position was such that they could not expect to immediately produce a satisfactory pressure cabin fighter for service operation – a lot of work still needed to be done.

Major A A Ross (Deputy Director R & D Engines) explained that Rolls-Royce was already working actively on a development of the Merlin XX in which the M-blower was retained but the S-blower was stepped up to give a rated height of 31,000ft (9,449m) – this developed engine should be available for prototypes in one year. Napier was in the early stages of investigating high-altitude versions of the Sabre with two-stage blowers, each stage of which had two speeds and which would have rated heights of 32,000ft (9,754m) and 40,000ft (12,192m) when the second stage was in operation. Based on this information, the Air Staff's revised performance estimates for the two-stage Sabre P.1004 were a maximum 370mph (595km/h) at 32,000ft and service ceiling 38,400ft (11,704m), while the Westland twin-Merlin would achieve 381mph (613km/h) at 30,500ft (9,296m) and reach 40,700ft (12,405m). Farren pointed out the advantage of the Sabre two-stage two-speed arrangement in that it maintained the speed within +/-10mph (16km/h) at all heights between 19,000ft (5,791m) and 32,000ft (9,754m) whilst the Merlin system suffered a loss in speed from 380mph (611km/h) at 32,000ft to 330mph (531km/h) at 19,000ft.

One of the advantages of the GAL.46 was that only 3,050lb (1,383kg) of light alloy would be used with almost no extrusions (the metal industry was currently very full with work) but, unlike the other pair, the design was not based on existing aircraft and the tricycle undercarriage was an additional complication. The Westland project had the disadvantage of using a very large amount of extrusions (1,300lb [590kg]) and in all a total of 6,400lb (2,903kg) of light alloy, while the centre plane, which was equal to half of the span and contained the engine mountings, nacelles, undercarriage and cannon gear, was a large and complicated component.

Farren summarised that, in regard to their structure and general layout, all of the designs were straightforward and it was really a question of deciding which of the design staffs could best undertake what would be largely experimental work. Hawker's design was the most practicable and declared the best, Westland's (like the Whirlwind) was 'rather fancy' and considered the worst, and General's was 'half-baked structurally'. It was agreed that Hawker and Westland were the most likely to undertake the work satisfactorily and that separate discussions with these companies should proceed before recommending which would be the best choice to do it.

On 8th January 1941 Sir Henry Tizard declared that the Hawker fighter/bomber layout was not specifically intended for high-altitude work; the pressure cabin could be fitted but he did not think it would be wise to concentrate Camm's attention on that just now. He also added that if the Whittle jet engine was a success it would make the specialised Westland high-altitude fighter redundant. The following day Beaverbrook, Minister of Aircraft Production, wrote to Westland to ask the company to put its full effort into the high-altitude fighter and to collaborate with Gloster on the solution of pressure cabins (which that company would need for its jet fighter).

A meeting held on 1st May 1941 asked for design work on the Westland F.4/40 airframe fitted with Griffon engines to proceed with all speed (in fact this was never built) but it was agreed that the first batch should use Merlins. The F.4/40 was named Welkin and the first of two prototypes made its maiden flight on 1st November 1942, ahead of contract. Altogether 75 production Welkins were eventually built (out of planned orders approaching 300), all of them Merlin-powered F Mk.1s except for one Mk.II two-seat radar night fighter to F.9/43; apart from the Mk.II, all of the completed Welkins were single-seaters. The RAF's interest in the Welkin had waned through 1944 and no example reached a squadron. Part of the reason for this loss of interest was the performance and better manoeuvrability of the Mosquito, which had been barely realised when F.4/40 was first laid down, but a further factor was the shortfall in the Welkin's own performance from the original estimates. Most were delivered to Maintenance Units and scrapped after the war.

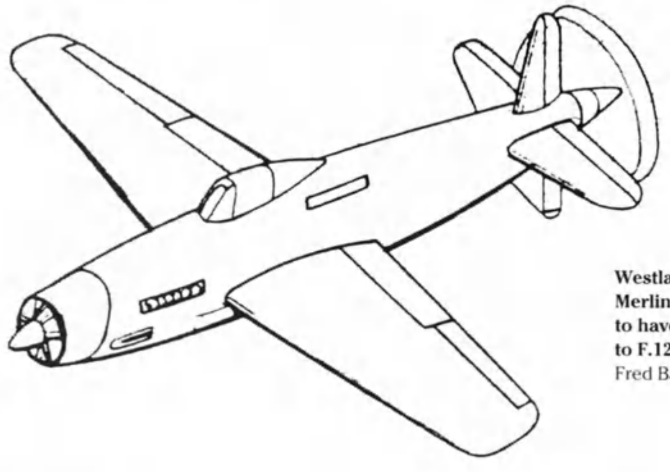
De Havilland Hornet

By the middle of World War Two de Havilland (DH) was looking at what might follow its famous Mosquito multi-role aircraft (Chapter 5) and the result was two fighters, the jet-powered DH.100 Vampire (Chapter 11) and a scaled down development of the Mosquito called the DH.103. The initial proposals for the second project with twin Merlin engines were passed to N E Rowe on 22nd September 1942. Talks between DH and MAP had concentrated on how to make use of a new and very cleaned up variant of the Merlin to meet a need for a long-range fighter to oppose Japanese single-engine fighters in the Pacific. The new engine was so free of accessories that the frontal area was virtually dictated by the crankcase and cylinder dimensions and it was not really suited to the Mosquito; a smaller aeroplane would be better. However, besides the DH.100 Vampire, the unarmed DH.102 Mosquito II bomber to B.4/42 (Chapter 5) was also being developed at this time and so the Air Staff placed the DH.103 on a low priority.

R N Liptrot assessed the DH.103 in early January 1943. The basic project covered an all-wood twin-Merlin single-seat fighter for low/medium-altitude duties to be produced generally on Mosquito lines. In low-altitude form with a span of 47ft (14.3m) and flying weight 14,700lb (6,668kg), DH predicted that the DH.103 would reach 474mph (763km/h) at 27,500ft (8,382m), but Liptrot concluded that there was not a good case for the project in the form presented when compared to the new single-engined F.6/42 fighter requirement (Chapter 1), which would be smaller and lighter. A request was made to give the aircraft greater range for operation in the Pacific theatre but, because of the Air Staff's lack of interest, the firm had now stopped work on the DH.103.

Towards the end of April 1943, when the latest engine developments were assessed, it was realised that two Merlin 61 engines offered considerably greater installed power than was possible with any single unit while, at the same time, the 61 was capable of further immediate development for the highest possible power output at all altitudes. This would give the twin-engine DH.103 a superior performance in speed and climb over what could be obtained with a single-engined aircraft to the same specification. Consequently interest in the DH.103 began to grow and DH now estimated that a speed of 490mph (788km/h) at 23,400ft (7,132m) was possible.

PX393 was a late de Havilland Hornet F Mk.3 with extended fin area. This view shows it with 64 Squadron, probably in late spring/early summer 1949. Barry Guess, BAE Systems, Farnborough.



Westland's tandem Merlin project, believed to have been prepared to F.12/43 (5.44).
Fred Ballam, Westland

Up to 1943 long-range fighters had generally suffered certain drawbacks, mainly concerning their manoeuvrability. By this time the need for such a type in the RAF was becoming obvious but if a similar design technique was used to the Mosquito the production stage could be reached quickly and there would be many advantages from having a twin-engined fighter, such as greatly increased power and improved pilot's view. It was also realised that, while there was no reason why a twin-engined fighter should suffer in most manoeuvres compared with others of similar power, there would be some loss in rate of roll. However, it was felt that any more than a certain rate of roll could not be used effectively and that this limit could be reached in the DH.103, while the layout itself gave the considerable advantage of central rather than convergent fire.

Since it was a scale model of the Mosquito, the DH.103 was expected to inherit the good aerodynamic, controllability and structural features of the latter and so hopefully suffer relatively little from teething problems. Rowe felt that the performance looked so good that 'it must not be overlooked' and on 11th May wrote 'the DH.103 is a very attractive proposition and I would like to see it built. Geoffrey de Havilland would also like to build it ... he has an eye for a good aeroplane ... but would not be disappointed if the Air Staff decides against it. The outstanding quality is that it retains extremely high performance with the ability to fight at long range and is likely to be invaluable in the Far East War in 1945/46'.

Prototypes were agreed on 20th June and ordered on 30th July, the first (RR915) a 'skeleton' to be completed in May 1944 while the second (RR919), two months behind, would be to the full standard. The first production aeroplane was to be ready in December 1944 and to get it into service quickly it was agreed to order 'off the board'; in early 1944 the type was named Hornet. Specification F.12/43 was written around it and called for as high a speed as possible but not less than 480mph (772km/h) at 22,000ft (6,706m), plus a maximum rate of climb of not less than 4,400ft/min (1,340m/min) from ground level to 22,000ft. Armament comprised four 20mm cannon and, for ground attack, two 1,000lb (454kg) bombs or eight rocket projectiles (RPs) under the wings. The Hornet's primary duty was to be a long-range medium-altitude single-seat day fighter but it would also be used as a fighter-bomber and unarmed photo-reconnaissance aircraft.

From the manufacturing point of view there was a need to combat the weathering problems suffered by the Mosquito. Consequently the Hornet employed a bonding resin called Redux which was used on the fighter to cement metal to wood to make composite spars for the wings, the first time the process had been used in an aircraft structure; Redux cement had been shown to resist higher stresses than could be withstood by wood-to-wood cements, or indeed the wood fibres themselves. In September 1943 contra-rotating propellers were considered as a counter to the considerable control problem of swing on take-off but it was eventually agreed with Rolls-Royce that handed engines with opposite-rotating propellers would be suitable.

The specially 'tailored' handed engines were known as the Merlin 130 series; the 130 was the conventional right hand rotating unit fitted in the port nacelle, the 131 in the starboard nacelle had a reverse-rotating (left hand) airscrew. These were two-speed, two-stage engines with downdraught carburettors (the first of the Merlin family to have this feature) and were mounted low so that a smooth airflow was obtained over the whole upper wing. Mosquito practice surfaced again with leading edge radiator intakes housed in an extended wing centre section; the air intakes were placed outboard of the nacelles.

A Mock-Up Conference to clear the design was held in September 1943, although the mock-up itself had been put together the previous January and for security was hidden behind a wall in Hatfield's Experimental Department. RR915 made its first flight on 28th July 1944 and by 22nd August had achieved a true airspeed at full throttle height of 491mph (790km/h) at 24,600ft (7,498m) in FS Gear (within 2mph [3.2km/h] of DH's latest estimate) and 460mph (740km/h) at 12,690ft (3,868m) in MS Gear – production aircraft would only reach 472mph (760km/h) at 22,000ft (6,706m). Not including special racing aircraft it is believed that the only aircraft to beat RR915 on the level with piston power was the Griffon 101-powered Supermarine Spiteful RB518 at 494mph (795km/h).

It appears likely that Westland also completed a project which used F.12/43 as a base. This design, completed in May 1944, had two 1,000hp (746kW) Merlins mounted in tandem with a shaft drive to contra-rotating propellers placed behind the tail. Its span was 45ft (13.7m), wing area 340ft^2 (31.6m^2), all-up-weight 23,000lb (10,433kg) and top speed 510mph (821km/h) at 25,000ft (7,620m).

The close of the war in the Pacific ensured that the Hornet production run was curtailed and many examples were cancelled. However, 193 fighters were built for the RAF and served in the Far East until 1955 while another 182 Sea Hornets were built for the Fleet Air Arm (Chapter 10). The Hornet was one of the most beautiful piston-engined aeroplanes ever produced and possessed a truly remarkable performance; together with the Sea Fury and some of the other types described in Chapter 1, it represented the peak of British piston engine fighter design. However the arrival of the jet very quickly made this high level of piston technology near redundant.

Twin-Engined Fixed-Gun Fighters – Estimated Data

Project	*Span ft in (m)*	*Length ft in (m)*	*Gross Wing Area ft^2 (m^2)*	*Max Weight lb (kg)*	*Engine hp (kW)*	*Max Speed / Height mph (km/h) / ft (m)*	*Armament*
Specification F.37/35							
Boulton Paul P.88A	39 6 (12.0)	32 8 (10.0)	260 (24.2)	6,573 (2,982)	1 x Hercules I c1,500 (1,119)	337 (542) at 15,000 (4,572)	4 x 20mm cannon
Boulton Paul P.88B	44 0 (13.4)	36 3 (11.0)	320 (29.8)	8,100 (3,674)	1 x Vulture 1,750 (1,305)	358 (576) at 15,000 (4,572)	4 x 20mm cannon
Bristol 153	37 0 (11.3)	25 3 (7.7)	204 (19.0)	?	1 x Hercules c1,500 (1,119)	357 (574) at 12,500 (3,810)	4 x 20mm cannon
Bristol 153A	37 0 (11.3)	25 6 (7.8)	?	?	2 x Aquila	370 (595) at 15,000 (4,572)	4 x 20mm cannon
Hawker F.37/35	40 0 (12.1)	32 3 (9.8)	258 (24.0)	c7,000 (3,175)	1 x Merlin	c320 (515)	4 x 20mm cannon
Supermarine 312	37 0 (11.3)	29 11 (9.1)	242 (22.5)	5,800 (2,631)	1 x Merlin 1,010 (753)	355 (571) at 15,000 (4,572)	4 x 20mm cannon
Supermarine 313	48 0 (14.6)	37 0 (11.3)	325 (30.2)	8,200 (3,720)	2 x Goshawk 855 (638)	390 (628) at 15,000 (4,572)	4 x 20mm cannon
Westland P.9	45 0 (13.7)	31 0 (9.4)	c250 (23.3)	8,400 (3,810)	2 x Kestrel K.26 1,710 (1,275)	395 (636) at 15,000 (4,572)	4 x 20mm cannon
Westland Whirlwind (flown)	45 0 (13.7)	31 6 (9.6)	250 (23.3)	10,377 (4,707)	2 x Peregrine I 885 (638)	356 (573) at 15,000 (4,572)	4 x 20mm cannon
Gloster F.9/37 (flown)	50 0.5 (15.3)	37 0.5 (11.3)	384 (35.7)	11,615 (5,269)	2 x Taurus TE.1 1,050 (783)	360 (579) at 15,000 (4,572)	5 x 20mm cannon
Bristol Beaufighter Mk.I (flown)	57 8 (17.6)	41 0 (12.5)	503 (46.8)	21,120 (9,580)	2 x Hercules III 1,400 (1,044)	330 (531) at 16,000 (4,877)	4 x 20mm cannon, 6 x 0.303in (7.7mm) mg
Bristol Beaufighter Mk.II (flown)	57 8 (17.6)	42 6 (13.0)	503 (46.8)	20,077 (9,107)	2 x Merlin XX 1,250 (932)	337 (542) at 22,000 (6,706)	4 x 20mm cannon, 6 x 0.303in (7.7mm) mg
de Havilland Mosquito Mk.II (flown)	54 2 (16.5)	40 10 (12.5)	454 (42.2)	18,547 (8,413)	2 x Merlin 21/23 1,480 (1,104)	370 (595) at 14,000 (4,267)	4 x 20mm cannon, 4 x 0.303in (7.7mm) mg
Specification F.6/39 and Vickers Projects							
Westland F.6/39 (1)	60 6 (18.4)	?	450 (41.9)	16,200 (7,348)	2 x Griffon 1,600 (1,193)	396 (637) at 16,000 (4,877)	4 x 20mm cannon
Westland F.6/39 (2) (pusher)	52 0 (15.8)	?	450 (41.9)	16,200 (7,348)	2 x Griffon 1,600 (1,193)	396 (637) at 16,000 (4,877)	4 x 20mm cannon
Vickers 414 (F.6/39)	53 0 (16.2)	42 3 (12.9)	394 (36.6)	14,950 (6,781)	2 Griffon RG.2.SM 1,700 (1,268)	439 (707) at 19,500 (5,944)	1 x 40mm cannon
Vickers 420 (F.16/40, 1.41)	53 0 (16.2)	43 10 (13.4)	394 (36.6)	16,454 (7,463)	2 Griffon RG.2.SM 1,700 (1,268)	461 (742) at 25,000 (7,620)	6 x 20mm cannon
Vickers 432 (flown)	56 10.5 (17.3)	39 3 (12.0)	450 (41.8)	19,721 (8,945)	2 x Merlin 61 1,520 (1,133)	380 (612) at 15,000 (4,572)	6 x 20mm cannon
Specification F.4/40							
Hawker P.1004	52 (15.8)	39 (11.9)	405 (37.7)	13,930 (6,319)	1 x Sabre 1S.M 1,850 (1,380)	380 (611) at 18,500 (5,639)	6 x 20mm cannon
General Aircraft GAL.46 (first, 10/39)	52 0 (15.8)	41 6 (12.6)	385 (35.8)	15,704 (7,123) fighter 17,845 (8,094) f/bomber	2 Merlin RM.2.SM 1,265 (943)	395 (636) at 20,800 (6,340)	4 x 20mm cannon, 4 x 500lb (227kg) bombs
Westland P.13	58 (17.7)	46 6 (14.2)	?	16,420 (7,448)	2 x Merlin XX 1,170 (872)	398 (640) at 21,000 (6,401)	6 x 20mm cannon
Westland P.14	60 (18.3)	41 6 (12.6)	450 (41.8)	16,340 (7,412)	2 x Merlin XX 1,170 (872)	368 (592) at 21,000 (6,401)	6 x 20mm cannon
Westland Welkin Mk.I **(flown)**	70 0 (21.3)	41 6 (12.6)	460 (42.8)	19,775 (8,970)	2 x Merlin 61 1,560 (1,163)	387 (623) at 26,000 (7,925)	4 x 20mm cannon
de Havilland Hornet F Mk.3 **(flown)**	45 0 (13.7)	36 8 (11.2)	361 (33.6)	17,880 (8,110)	2 x Merlin 130/131 2,070 (1,544)	472 (760) at 22,000 (6,706)	4 x 20mm cannon

Chapter Three

Turret Fighters

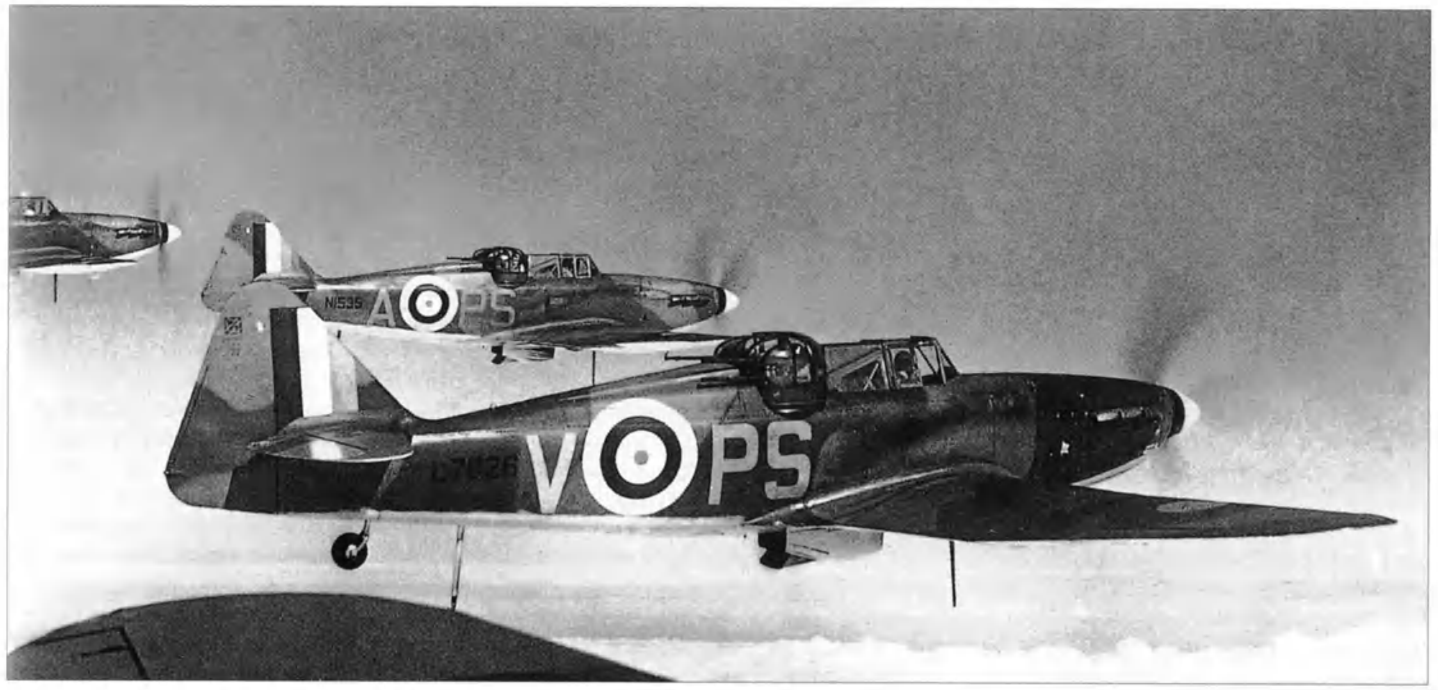
When the Second World War began in 1939 the developments that had taken place in all areas of aviation since the end of the first World conflict in 1918 were immense but there were unknowns as to just how effective some of new military aircraft might be. The types that were designed during the build-up to war were, to some extent, produced against theory rather than fact, although the Spanish Civil War of 1936 did supply valuable experience at a vital time. Some British aircraft developed during this period, like the Spitfire and Hurricane, proved to be a great success but others were flawed. One example was the turret fighter which today, familiar as we are with dogfighting and close-in air-to-air combat, may seem to have been rather an odd concept. However, it was the outcome of serious thought regarding how the forthcoming conflict might be fought, during a time when there was a need to cover every possible eventuality.

A theory that was generally accepted at this time was that Britain would be attacked by massed formations of enemy bombers. To counter this it was felt that the defending fighters would have to attack in formation but there were doubts as to whether the pilots would be capable of formating with their colleagues while aiming their guns. The solution could be to concentrate the guns in a power-operated turret and from the mid-1930s there were several attempts to acquire 'modern' turret-armed fighters. Wartime experience eventually showed that the fixed-gun Spitfire/Hurricane arrangement was superior and after 1940 the idea of the turret-armed 'bomber destroyer' faded away.

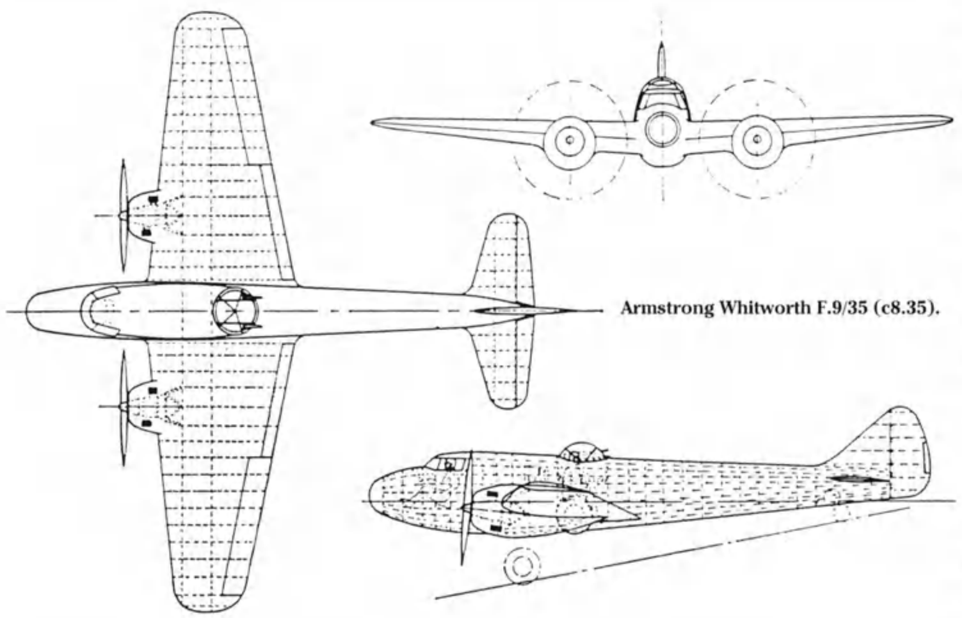
Specification F.9/35 Boulton Paul Defiant and Hawker Hotspur

In 1934 some British companies were experimenting with power-operated gun mountings or turrets. One, Boulton and Paul Aircraft, had achieved some success with its Overstrand medium bomber and in 1935 it acquired from the French company SAMM a four-gun power-operated turret. Boulton Paul considered this equipment to be far in advance of anything they, or the other British turret-designing firm Frazer Nash, had so far achieved.

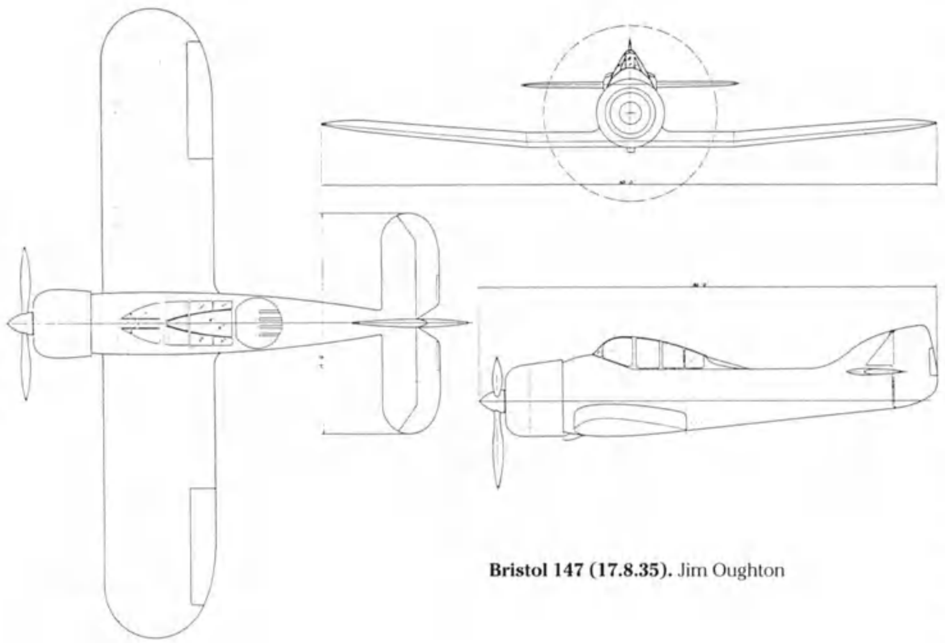
One early turret fighter specification was F.5/33, but the concept here was for a pusher fighter with a nose turret which appears to have been abandoned when it became clear that it did not offer a sufficient advance over current fighters. A prototype of one of the designs tendered, the Armstrong Whitworth AW.34, was ordered but not completed. A much more successful document was F.9/35 for a two-seat day and night fighter with a speed of not less than 290mph (467km/h) at 15,000ft (4,572m), which gave birth to the RAF's only wartime turret fighter, the Defiant. The aircraft was to have no forward-firing armament, the offensive gunnery being placed in a rear cockpit, and the document added, quite delightfully, that 'the gunner shall be completely sheltered from the wind and be able to operate his guns without appreciable effort, whatever the speed of the aircraft may be'. F.9/35 was issued to Tender in June 1935 and resulted in the following proposals.



Boulton Paul Defiant fighters of No 264 Squadron.



Armstrong Whitworth F.9/35 (c8.35).



Bristol 147 (17.8.35). Jim Oughton

Armstrong Whitworth F.9/35

This design, which was unnumbered but a development of the AW.34, was the only twin-engined contender, making use of two Armstrong-Siddeley Terrier engines. The mainplane employed the then current AWA practice of a single box spar made in light alloy where the bending moment stresses and torsional loads would be accommodated by wide booms to give a light and rigid plane. The wing was covered in light alloy from the spar's leading edge through to its rear but the areas aft of this had standard fabric covering. It was also intended to have a fuselage and wing surface finish approaching the quality achieved at the time on motor cars, this being accomplished using flush riveting and cellulose lacquers. A contract was placed for one prototype, K8624, which may have been a conversion of the part-complete AW.34 prototype, and it seems likely that this aeroplane's assembly was well advanced when the order was cancelled. Sources suggest that cooling problems with the Terrier engines may have been partly responsible for the abandonment.

Boulton and Paul P.82

This project had a completely rotating turret behind the pilot's cockpit fitted with four 0.303in (7.7mm) Browning machine guns, which covered a field of fire equal to nearly the whole of the upper hemisphere. Firing forward over the airscrew and backward and alongside the rudder was made possible by retracting local portions of fairing fore and aft of the turret. Light alloy monocoque construction was used for the fuselage, tail unit and wings and on the fuselage was novel in the sense that this was constructed in sections for bolting together, a method successfully employed on Boulton Paul's Feeder Line aircraft for Imperial Airways. It was considered to much reduce the difficulties of monocoque construction and repair brought about by the inaccessibility of many rivets. The tailplane was built integrally with the fuselage and the wing was metal throughout, except for some possible fabric covering on the ailerons. Frise ailerons and split flaps were fitted, the latter extending from the body side to the ailerons.

Recessed stowage space for racks to carry light bombs was available in the inner part of each outer wing; when no bombs were carried these recesses would be faired over by cover plates (this feature did not find its way onto the prototype Defiant). Each wing also housed a fuel 42gal (191lit) tank, rate of climb up to 15,000ft (4,572m) was 2,450ft/min (747m/min), time to 25,000ft (7,620m) 12.0 minutes and service ceiling approximately 34,000ft (10,363m). A considerable amount of the development work carried out for Boulton Paul's tender to the B.1/35 bomber requirement (Chapter 6) was also applicable to this aircraft. The P.82 was to enter service as the Defiant but none of the original drawings still exist; just how many changes were made between project and hardware is therefore unknown. A prototype drawing dated 6th October 1936, fourteen months after the initial proposal, shows that by then the basic shape with underbelly radiators had evolved, although there were still suggestions for the original alternative under the nose.

Bristol 147

This used the same wing, tail unit and pilot's cockpit as Bristol's Type 148 two-seat army co-operation aircraft designed to A.39/34, which itself used many parts standard to the Type 146 proposed to F.5/34 (Chapter 1). The biggest change was the addition of the rear turret, faired into the rear cockpit, which housed four Browning machine guns. The rear crewman sat inside the cockpit ahead of the guns and aimed remotely using a reflector sight and two hand wheels. A 65gal (296lit) fuel tank was placed under the pilot and at least one more in the wing held another 18gal (82lit). Two versions of the aircraft were tendered in August and September 1935 respectively, the first using a Bristol Perseus engine while the second (the Type 147A) had a more powerful Bristol Hercules. Both were expected to achieve a service ceiling of 35,000ft (10,668m).

Fairey F.9/35

This used a single Hercules engine and its four-gun turret, when facing rearwards, was blended flush with the pilot's cockpit.

Gloster F.9/35

No information has been traced for this single-engine design.

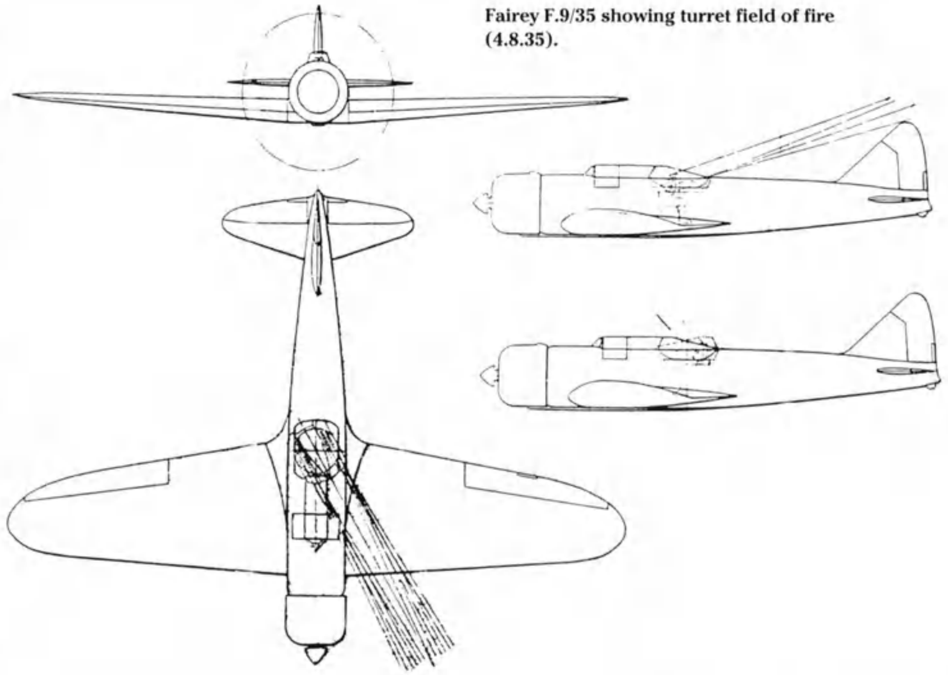
Hawker F.9/35

This project had a close similarity in its airframe design to the Hurricane and was to fly as the Hotspur. As first proposed, however, it had a larger span and used some upper rear fuselage decking to fair the turret into the fuselage when not in use; this could be lowered when it was time to fire or rotate the turret. The four machine guns were placed in vertical pairs to each side of the turret.

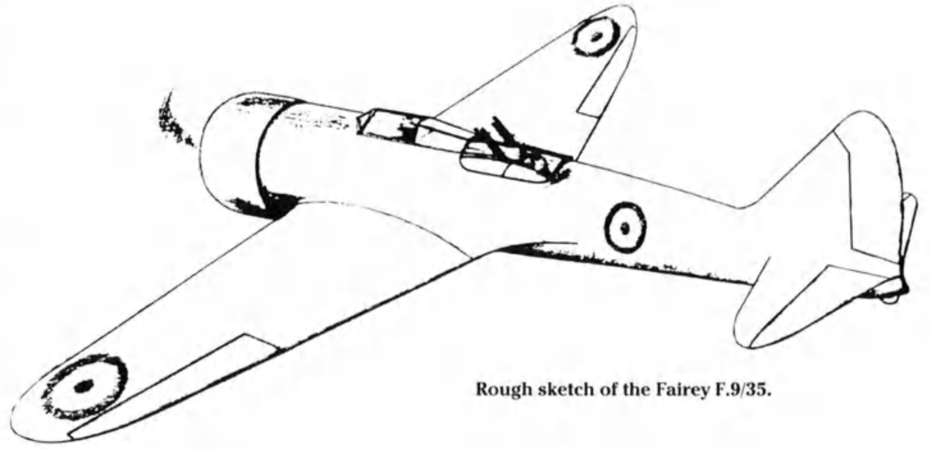
Supermarine 305

This was another development of Supermarine's F.7/30 (Type 224) and F.37/34 (Spitfire) fighters and indeed was near identical to the latter apart from the necessary modifications to the fuselage to covert it from a single to a two-seat aeroplane. The wings, engine installation, tail unit and chassis remained substantially unaltered which prompted Supermarine to suggest that the aircraft could be designed and constructed in a very short time. Great attention was given to reducing 'parasite drag' with the fuselage, wing and tail covered entirely with smooth flush-riveted sheet metal while all excrescences from the cockpits and turret were cut to a minimum.

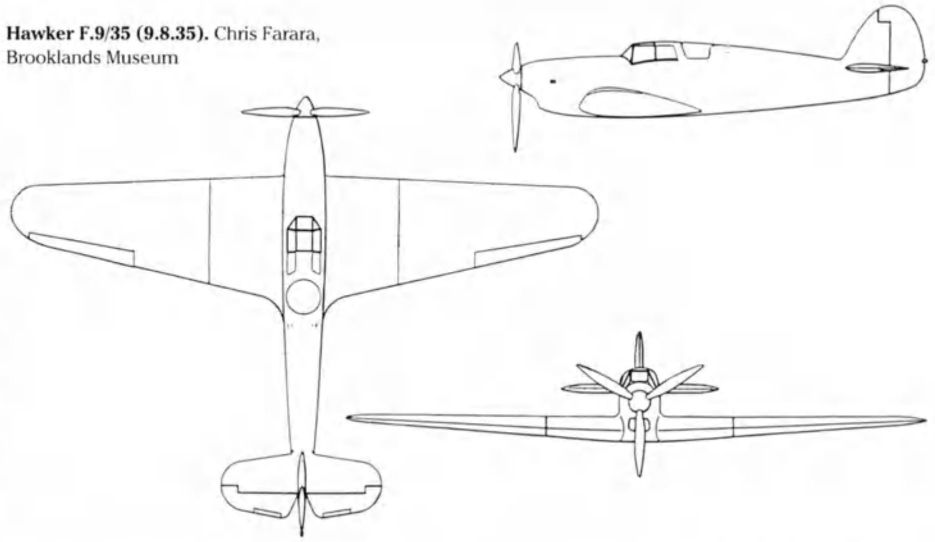
The 305's structure and chassis were identical to the F.37/34 (then currently building) and the Merlin installation was very similar. The cantilever wing used a single light alloy spar to which was attached the torsion-resisting leading edge box and the trailing ribs; the air brakes and landing flaps were of the split type. Flush riveted semi-monocoque construction was used on the fuselage and only the engine mounting employed tubular construction. Originally four 0.303in (7.7mm) Browning machine guns were mounted in a turret that was separated from the gunner but these were later replaced by four Lewis guns.



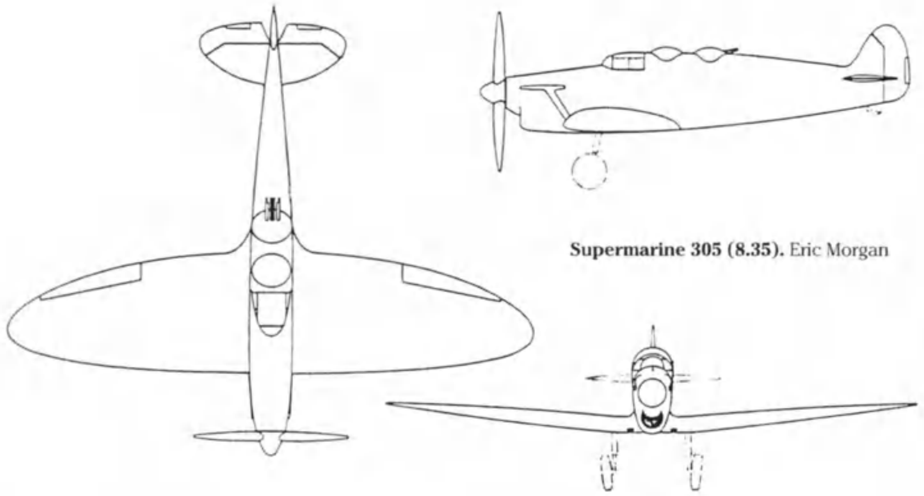
Fairey F.9/35 showing turret field of fire (4.8.35).



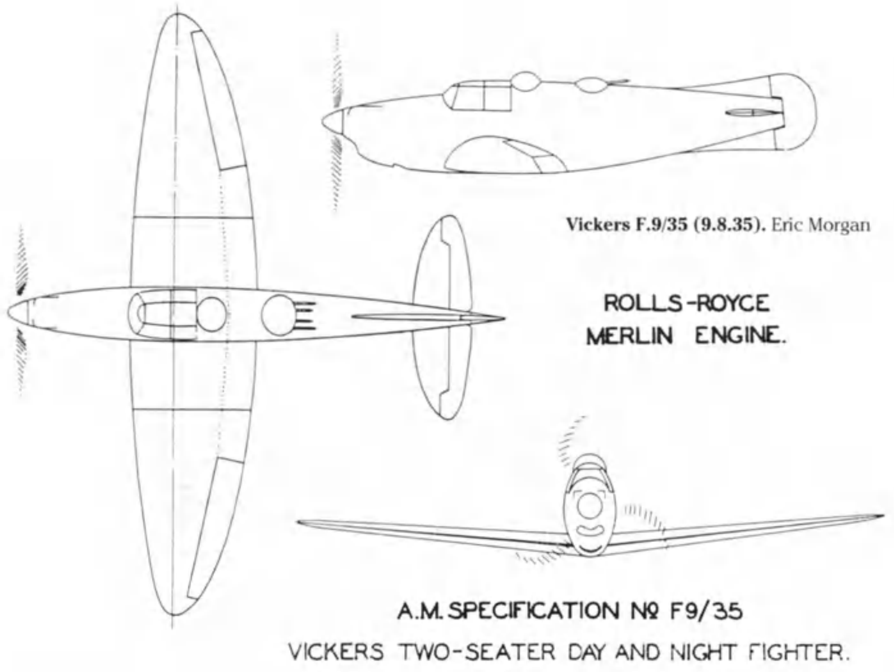
Rough sketch of the Fairey F.9/35.



Hawker F.9/35 (9.8.35). Chris Farara, Brooklands Museum



Supermarine 305 (8.35). Eric Morgan


ROLLS-ROYCE
MERLIN ENGINE.
A.M. SPECIFICATION Nº F9/35
VICKERS TWO-SEATER DAY AND NIGHT FIGHTER.

Vickers F.9/35 (9.8.35). Eric Morgan

Vickers F.9/35

It appears that this Merlin-powered design was not officially tendered to the Air Ministry. No data for it has been traced.

The Tender Design Conference was held on 12th September 1935 and placed the top three designs, in order of merit, as Hawker, Boulton Paul and Armstrong Whitworth; Bristol and Gloster were eliminated because of their unsatisfactory turret design. All of the contenders quoted a speed considerably in excess of the requirements and, in particular, the French turret on the Boulton and Paul P.82 excited very favourable comment. The Air Ministry attached great importance to the operational role of this type and was therefore very anxious to order prototypes of several designs; in addition it wanted duplicate prototypes as an insurance against mishap. As a result the financial allocation was exceeded and special Treasury sanction had to be obtained to order seven prototypes, two each from Hawker, Boulton Paul and Fairey and one from Armstrong Whitworth. Contracts for these were placed shortly afterwards (to Boulton Paul on 4th December) but, in the event, the Armstrong Whitworth and Fairey machines were never built and only one Hawker Hotspur was completed.

The first P.82 prototype, later named Defiant, was built during 1936 and 1937, the final Mock-Up Conference having convened on 28th February 1936; the first flight took place on 11th August 1937. To begin it appears that the Air Ministry's primary interest in the P.82 lay in its turret and in June 1936 it was thought that, due to a production order also having been given for the Hawker F.9/35, the likelihood of the aircraft going beyond the experimental stage was remote. However, it seemed worthwhile to continue with the P.82 because of the interest that the armament division took in the turret, quite apart from the aircraft itself. However, when DTD visited Boulton Paul's factory in September to see the prototype being built, he was struck by the apparent simplicity of the methods of production used on it.

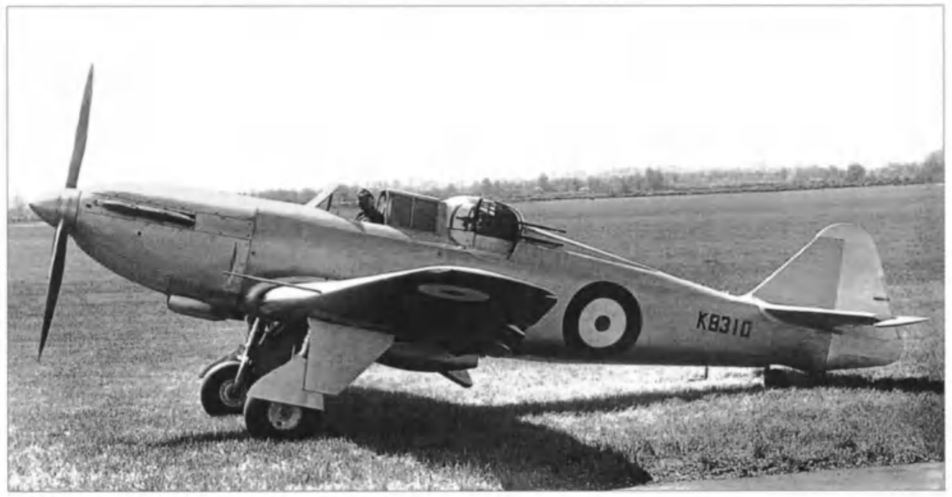
A recommendation by DTD that a small order for P.82s should be placed was rejected on the grounds that the company had not yet shown its skill as a producing unit and was in any case fully occupied with work for Blackburn. In the spring of 1937, however, this decision was reversed when an order for 87 Defiants was placed following a serious setback to the Hawker Hotspur programme. Boulton Paul was enthusiastic about its design, and with turrets generally, and was also considered to have produced an excellent design for the F.11/37 fighter (below) when, on the other hand, Hawker appeared to show more interest in fixed front gun fighters than the turret variety which was one reason why it took that company so long to get its prototype into the air.

Later that year CAS agreed to drop the Hotspur altogether in favour of the Defiant and in January 1938 the Council Committee on Supply agreed to adopt the Defiant as the sole two-seat fighter type, increasing Boulton Paul's order to 389. However, because Boulton Paul was occupied with producing the Blackburn Roc, deliveries did not begin until September 1939, and not in quantity until summer 1940. In April 1940 the Air Council agreed that, as an operational type, the Defiant had entered service two years too late and was thus verging on obsolescence. The manufacturer had estimated a speed of 315mph (507km/h) for the fighter but its true speed was 304mph (489km/h). Despite achieving some success in the Battle of Britain, the Defiant had a generally unhappy career as a day fighter and the shortcomings of the turret fighter concept were exposed. During the night bombing attacks of winter 1940/41 it was used extensively as a night fighter but it could not fulfil the Air Staff's needs for speed, armament and range and was subsequently converted into a target-tug. Over 900 Defiants were eventually built.

As noted, Boulton Paul had been fully occupied building the Blackburn B.25 Roc, an adaptation of the Skua naval fighter/dive bomber into a two-seat fleet turret fighter. This project was proposed to Specification O.30/35 and the prototype first flew on 23rd December 1938. Against O.30/35 Boulton and Paul offered the P.85A (Hercules) or P.85B (Merlin) development of the P.82 (a 'Sea Defiant') with a new tail, deeper fuselage and leading edge slats to reduce the landing speed. Its span was 42ft 6in (13.0m). Despite offering an estimated top speed of 308mph (496km/h), 85mph (137km/h) more than that achieved by the Roc at 223mph (359km/h), the Roc was chosen for the Fleet Air Arm. Ironically, because Blackburn was full with work, it sub-contracted the Roc's detail design and production to Boulton Paul (who labelled the project P.93). The Roc was a failure because it was just too slow to catch enemy bombers.

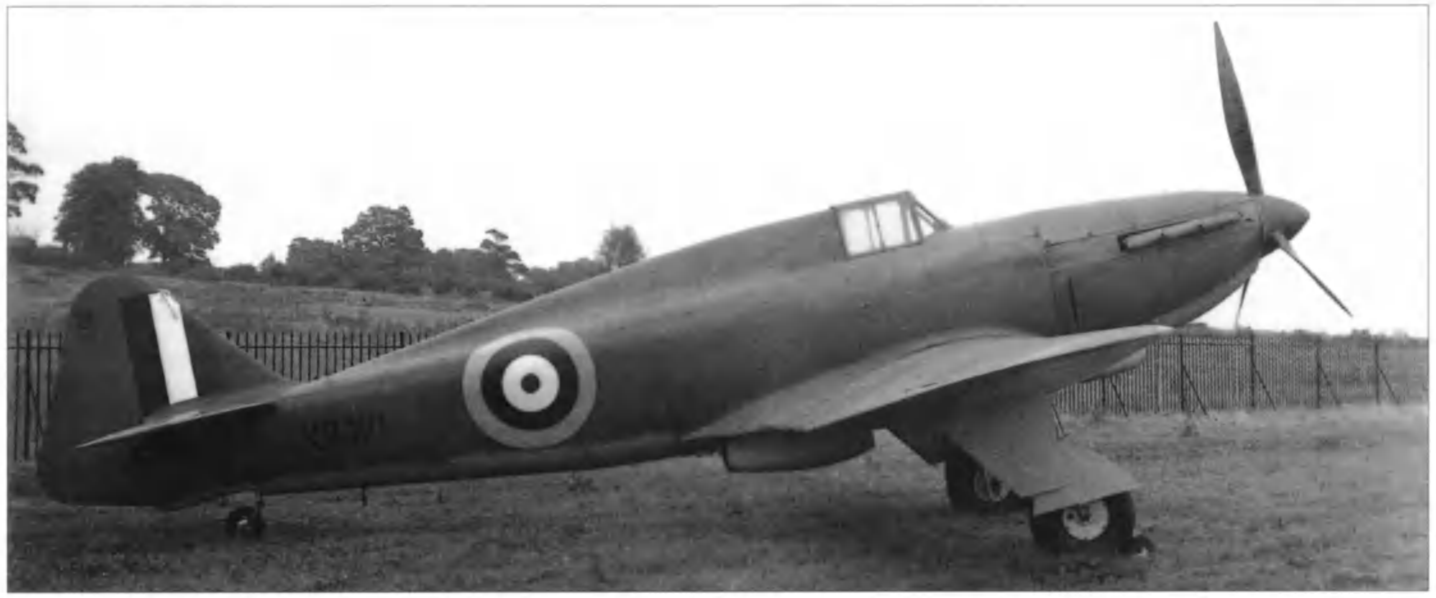
Boulton Paul P.94

Prototype Defiant K8310 eventually had its turret removed and in August 1940 was flown as an unarmed flying demonstrator for a fixed-gun version called P.94, which was intended for rapid production using many complete Defiant components. The P.94 had the turret replaced by twelve 0.303in (7.7mm)

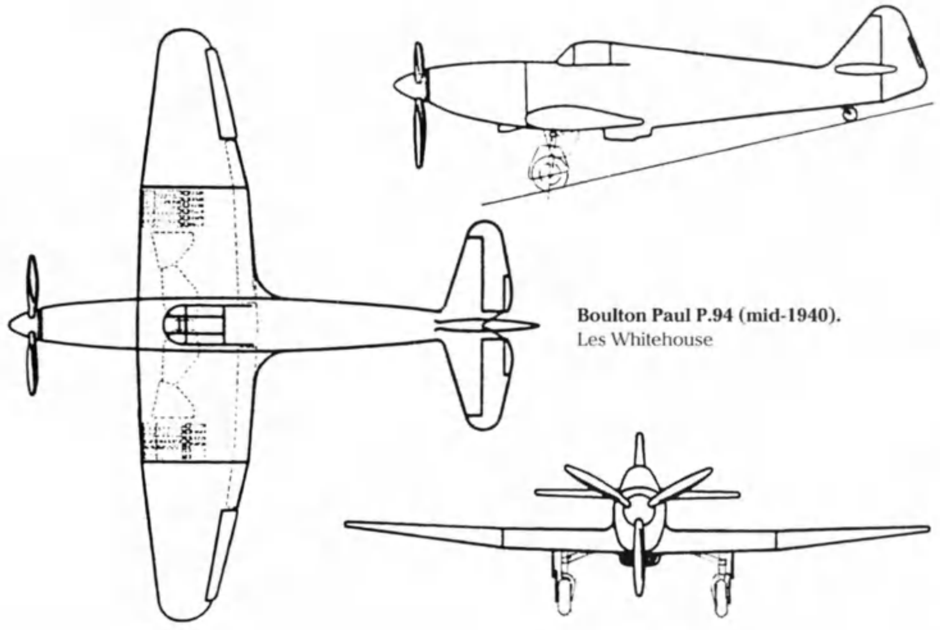


Boulton Paul Defiant prototype K8310 with its turret and guns fitted.

Air-to-air view of an unknown Defiant. Rolls-Royce



K8310 again, this time in 1940 after it had been converted into a single-seat fighter with no turret. Alec Brew (Boulton Paul Association)



Boulton Paul P.94 (mid-1940). Les Whitehouse

Browning machine guns disposed in each side of the wing centre section in nests of six – four 20mm Hispano cannon replacing eight of the Brownings in two nests of two each were an alternative while the machine guns could also be depressed 17° for ground attack work. P.94 had a 1,100hp (820kW) Merlin XX which offered a maximum speed of 360mph (579km/h) at 21,700ft (6,614m), a sea level rate of climb of 3,235ft/min (986m/min) and would get the aircraft to 25,000ft (7,620m) in 8.1 minutes (these figures were deduced from K8310's flight trials). To allow the type to act as a long-range fighter two 30gal (136lit) auxiliary fuel tanks could be carried and in production the aircraft would use standard Defiant jigs. The P.94 was never ordered but Boulton Paul also proposed to convert the now single-seat Defiant prototype into a four cannon fighter demonstrator. The Air Ministry's rejection of this idea was recorded at a company board meeting on 26th September 1940.

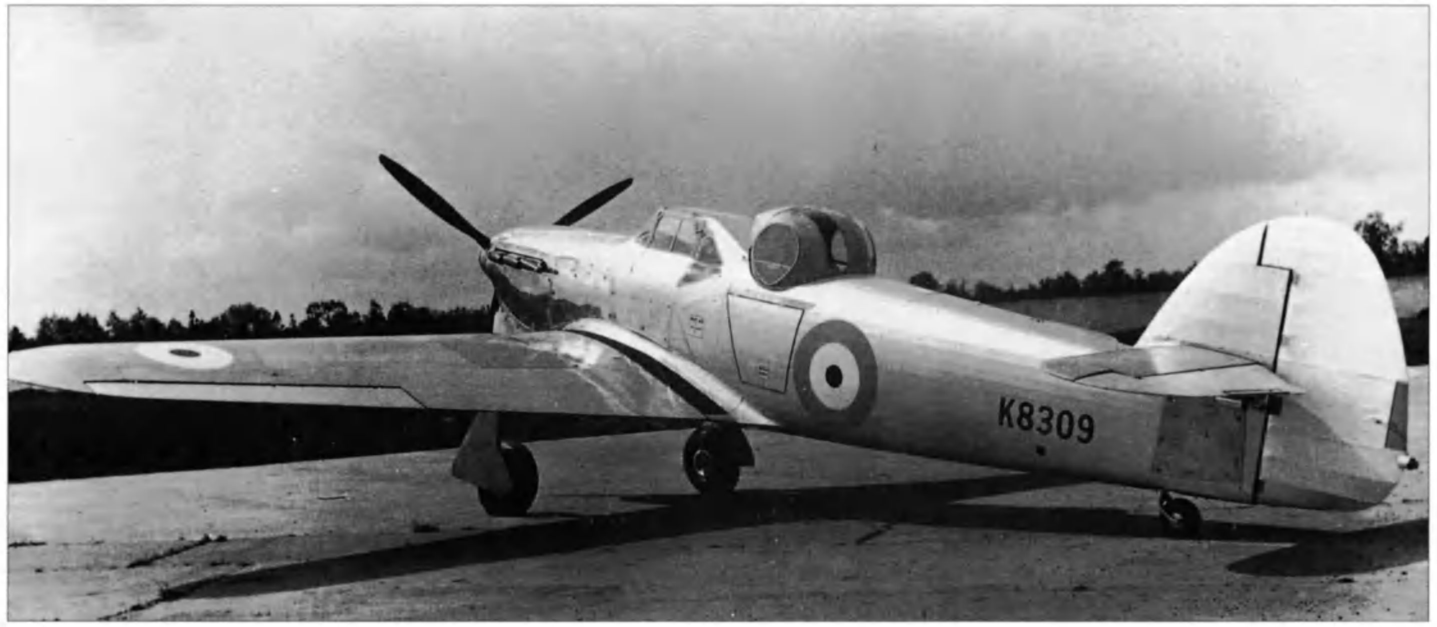
Hawker Hotspur

Hawker's F.9/35 project was christened Hotspur. The gunner's cockpit was built with a fully-enclosed power-operated turret containing four Browning machine guns and there was provision for one Vickers gun on the port side of the fuselage. Prototype K8309, flown on 14th June 1938, was the only Hotspur built because the planned production run was dropped when it was realised that capacity was limited for the quantity manufacture of additional new designs. Hawker was under growing pressure to accelerate quantity production of the Hurricane while its sister Hawker Siddeley company Gloster Aircraft was fully occupied building the Henley light bomber (Chapter 4). K8309 was used for research at RAE until February 1942.

Specification F.11/37
Boulton Paul P.92

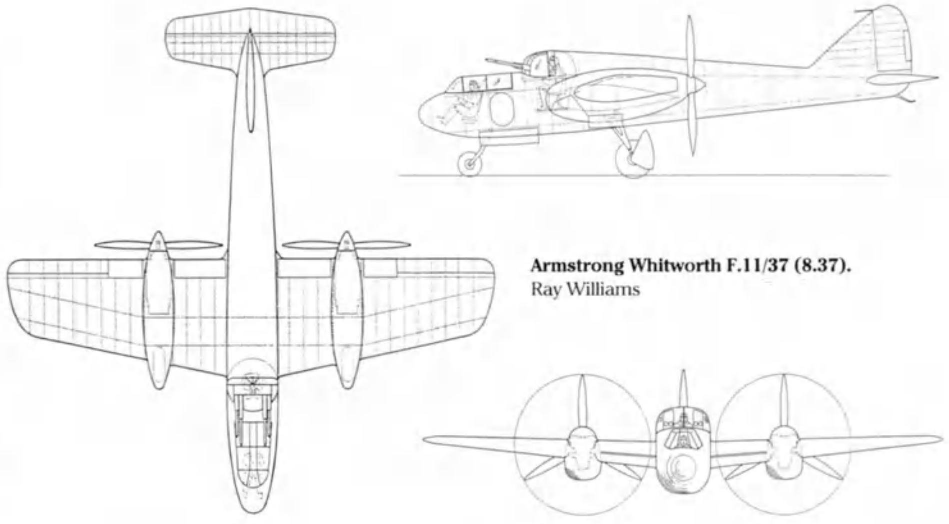
Another turret fighter specification was F.34/35 which described a twin-engined Gloster design that was eventually abandoned and replaced by the fixed-gun G.39 (Chapter 2). The next, F.11/37 dated 26th May 1937, called for a twin-engined home defence day and night fighter capable of at least 370mph (595km/h) at 15,000ft (4,572m) and, 'in order to obtain a striking power superior to the eight gun machine gun fighter', it would have four 20mm cannon in a power-operated turret. One 250lb (113kg) bomb was also to be carried internally. The following designs are known to have been prepared to F.11/37 (there may be more) but available Ministry documents make reference only to Boulton Paul's project.

K8309, the only Hawker Hotspur to be completed, seen with a wooden dummy turret and no guns. The real turret was never fitted. Eric Morgan



Armstrong Whitworth F.11/37

AWA concluded that F.11/37's primary objective was a fighter that would usually attack a target flying in front of it; consequently this unnumbered design had the pilot sat in the nose with his gunner and turret just behind and above. Two Merlin pusher engines were fitted to allow the gunner the maximum forward field of fire, although his turret could be rotated through 360° except for a small area directly behind; in addition the guns could not be lowered to the horizontal. This was AWA's first project to have no fabric-covered surfaces, stressed skin light alloy construction being used throughout, and also the first to have a retractable tricycle undercarriage complete with steerable nosewheel. Petrol was housed in two upper fuselage tanks directly behind the turret and the 250lb (113kg) bomb container and rack were carried in a lower fuselage bay behind the turret.

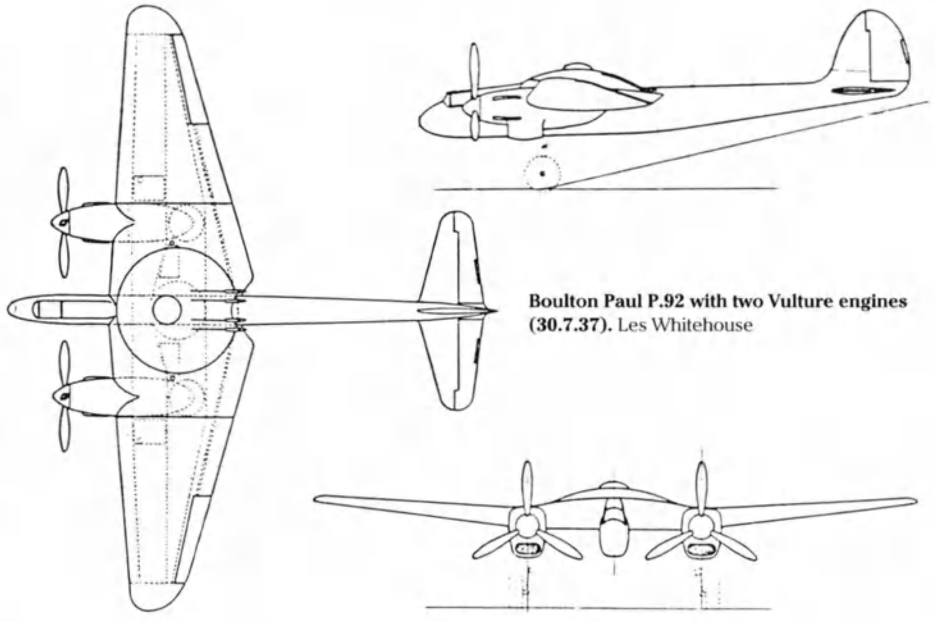


Armstrong Whitworth F.11/37 (8.37). Ray Williams

Boulton Paul P.92

This attractive design had a very slim fuselage and two Vulture engines and managed to accommodate a large 13ft (4.0m) diameter turret in a combined fuselage and a thickened wing centre-section mounting between the engine nacelles. The four 20mm Hispanos were housed in recessed slots, except when elevated above about 30°, and the gunner had a small offset transparent sighting hood. To prevent distortion and ensure that the turret would always rotate freely, considerable structural stiffening was required around the turret and between the wing spars. The turret itself was built in light alloy over braced ribs and the only part not housed within the wing was the carefully faired shallow dome which ensured that resultant drag was minimal. The fuselage was of monocoque construction throughout with light alloy sheet skinning and stiffened by longitudinal corrugated stringers built on to a series of ring formers and built-up bulkheads. Both turret and wing/fuselage centre section were mocked-up and photographed for the original submission, the wing/turret shape having already been tested in the wind tunnel.

One drawing also showed four 0.303in (7.7mm) Browning machine guns outboard of the specified cannon, stacked one above the other two per side, while a 250lb (113kg) bomb container could be carried as an alternative load. P.92's wing had split flaps and Frise ailerons and the engine radiators were placed on the front of the nacelles. A total of 270gal (1,228lit) of fuel was carried in four tanks. Estimated rate of climb was 3,080ft/min (939m/min) at sea level and 3,220ft/min (981m/min) at 15,000ft (4,572m); service ceiling 38,000ft (11,582m). This aircraft was chosen for construction and as the design evolved it acquired a fin fitted with a straight leading edge.

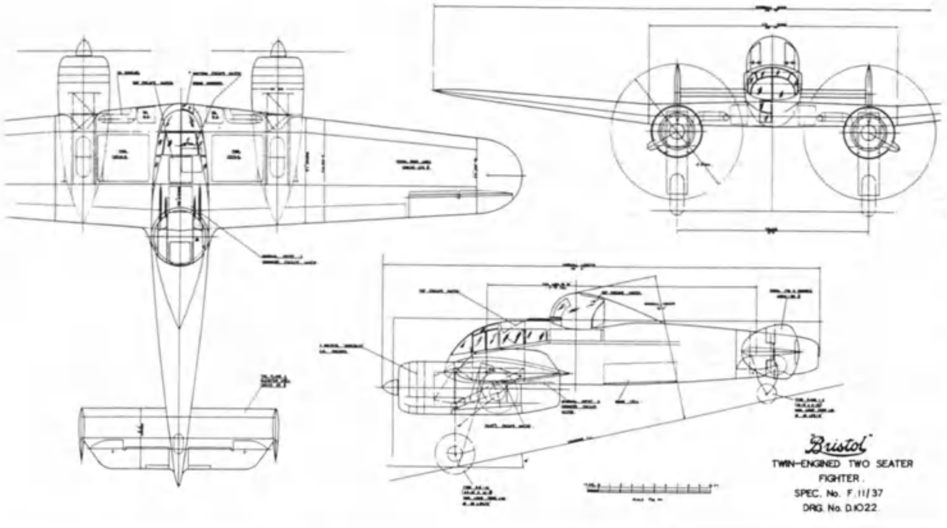


Boulton Paul P.92 with two Vulture engines (30.7.37). Les Whitehouse

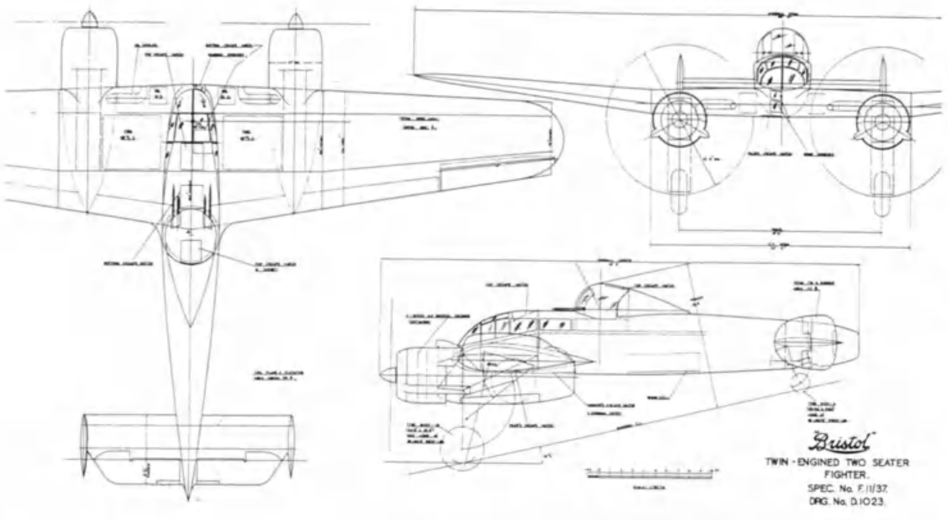
Bristol F.11/37

This brochure described two versions of the same design which were distinguished as 'Small' and 'Large' but, surprisingly, not given a type number. The first had a pair of Bristol Hercules HE.6.SM units while the larger variant would take two examples of a new 2,000bhp (1,491kW) 18-cylinder two-row radial to be made by Bristol in the 'immediate future' (at this stage the engine was provisionally named Centaurus). To ensure a design wing loading of 30lb/ft^2 (146kg/m^2), and so compensate for the differing weights and size of the powerplants, the two projects had different wing and tail areas, tail lengths and undercarriages, otherwise they were practically identical. The materials and methods of construction to be employed would be generally similar to the Beaufort torpedo bomber but incorporating any improvements thought necessary from experience.

Standard two-spar wing construction was used with the pilot seated between the spars and, to maintain the chief requirement of a clean upper hemisphere for gunfire, the engines were mounted in nacelles fitted flush with the top of the wing surface. Dependent on the type of engine fitted, engine cooling was obtained by either ducted or bottom-gilled cooling passages which exhausted below the wing surface. The low wing position enabled the guns to have a clear field of fire horizontally forward over the airscrews



Bristol's 'Small' design to F.11/37 (8.37). Jim Oughton



Bristol's 'Large' design to F.11/37 (8.37). Jim Oughton

and afforded the pilot an excellent view for formation flying. The roof of the pilot's compartment was protected from gun blast by reinforced panels and just aft of the turret a cell in the floor was arranged to carry the 250lb (113kg) small bomb container on a universal rack; hydraulically-operated doors opened this compartment for the bombs to be released. Both aircraft carried fuel in two wing tanks, the 'Small' design having 245gal (1,114lit) in total and the 'Large' 315gal (1,432lit).

The data for the 'Small' machine included a maximum rate of climb, at 5,000ft (1,524m), of 3,620ft/min (1,103m/min), which at 15,000ft (4,572m) dropped to 2,900ft/min (884m/min), time to 15,000ft was 4.6 minutes and to 30,000ft (9,144m) 12.0 minutes, service ceiling 40,000ft (12,192m) and absolute ceiling 41,000ft (12,497m). The equivalent figures for the 'Large' version were 3,590ft/min (1,094m/min) (maximum rate of climb actually at sea level), 2,500ft/min (762m/min), 4.7 and 13.7 minutes, 41,500ft (12,649m) and 42,500ft (12,954m).

Gloster F.11/37

This project followed the basic design of the Gloster G.39 in its original form as a two-seat fighter (Chapter 2) but with more powerful engines. It was a cantilever mid-wing aircraft with outboard engines and retractable undercarriage and the tail had twin rudders and fins; the pilot was seated ahead of the mainplane. A fully retractable turret, located immediately aft of the rear main spar, housed four 20mm Hispano cannon or, as an alternative, two 23mm Madson automatic guns. Apart from the gunner's head fairing, this turret was flush with the fuselage when in the 'down' position. A total of 280gal (1,273lit) of petrol was carried and alternative powerplants were two Rolls-Royce Vultures, Armstrong Siddeley Deerhounds or Bristol Hercules; the Vulture offered an estimated 8.7 minutes to 25,000ft (7,620m).

During 1937 Gloster also proposed a sister F.11/37 bomber with Hercules HE.6.SM engines and the same centre wing, centre sections and engine installations. Nine 250lb (113kg) or six 500lb (227kg) bombs, or a single 2,000lb (907kg) torpedo could be carried, span was 60ft (18.3m) and for a gross weight of 20,530lb (9,312kg) the aircraft was expected to achieve 353mph (568km/h) at 15,000ft (4,572m).

Hawker F.11/37

No drawings or data are known to have survived for this twin-engined two-seat turret fighter tendered to F.11/37 in mid-1937.

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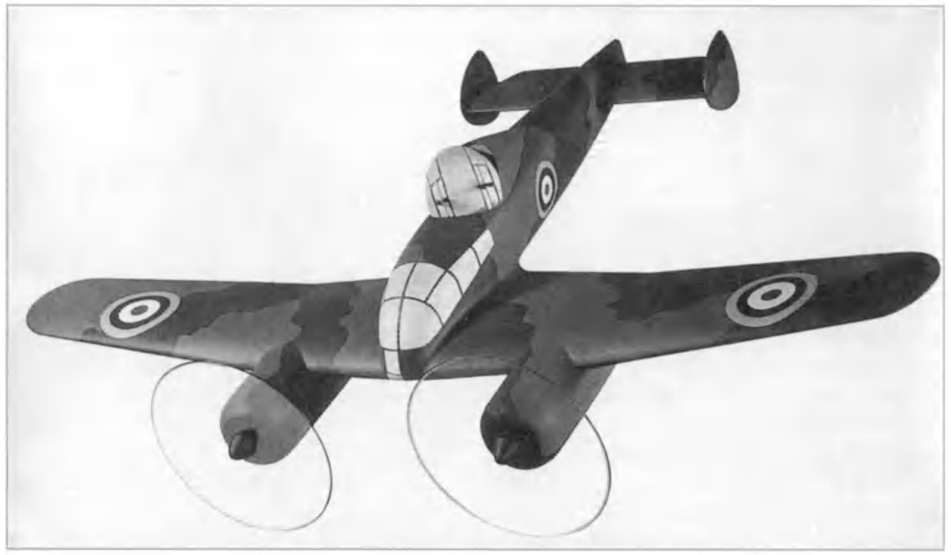
The Boulton Paul P.92 was selected as the winning design and a contract for two prototypes, L9629 and L9632, was placed on 2nd March 1938, one to have 1,760hp (1,312kW) Vulture IIs and the other 2,055hp (1,532kW) Napier Sabre I engines. The mock-up was examined on 31st May and their construction began in 1939. To ensure that it was a satisfactory aeroplane it was considered essential that the first aircraft should be tested without reference to the turret operation, while both prototypes would also be used to develop the engine installation. On 16th November 1938 it was recommended that an additional Vulture installation should be ordered and that both prototypes should now be completed with the Rolls engine, while a third would be ordered for the Sabre (serial V9258). At this stage Boulton Paul expected L9629 to be completed in January 1940 and L9632 about four months later, but some delays were expected due to the concentration of the company's drawing office staff on the Defiant.

On 7th January 1939 it was revealed that the first machine was now unlikely to be ready for flight test until March 1940 because the centre section turret housing involved some difficult aerodynamic problems with inevitable air leakage around the periphery of the dome and through the gun apertures. These problems were expected to be overcome but, to obtain additional aerodynamic data and help with the problem, a 2/7th scale wind tunnel model was tested by RAE. This showed that, with the guns elevated to 45° and turned to 135°, drag was increased by as much as 35%. Therefore a piloted scale model prototype, labelled P.92/2 and serialled V3142, was also ordered to further examine the type's drag and aerodynamic qualities. This all-wood aircraft was built by Heston Aircraft as the J.A.8 (Boulton Paul was too busy with the Defiant to be able to build this machine as well) and was powered by two 130hp (97kW) de Havilland Gipsy Major II engines. It had a span of 33ft 1.5in (10.1m) and length 27ft 6in (8.4m) and the turret was represented by a wooden hump; there were no dummy guns. Gross weight was 2,778lb (1,260kg) and the aircraft achieved a maximum speed of 152mph (245km/h).

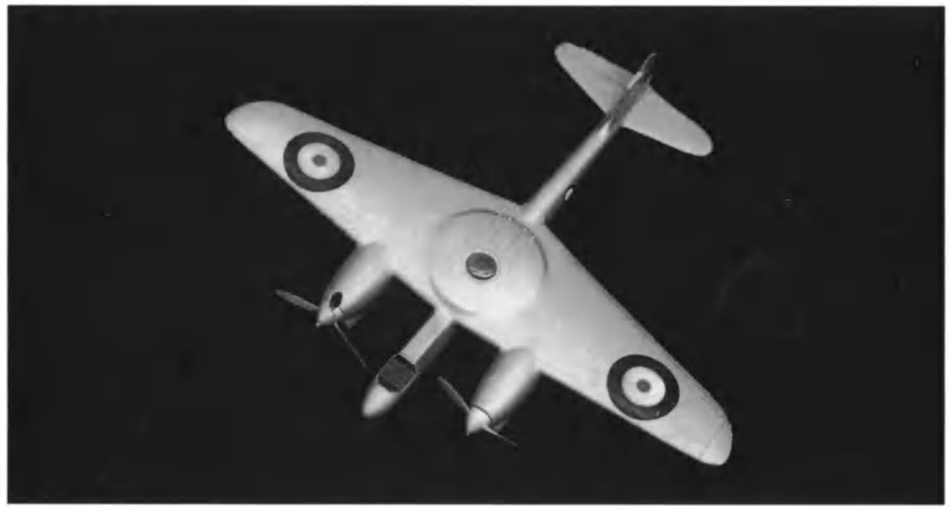
A Ministry memo dated 5th March 1940 states that Boulton Paul 'was energetically pursuing the building of three prototypes' but the P.92 was then cancelled on 26th May (published sources state that at this point the prototype's structures were only about 5% complete). The reasons for the suspension were the German advance and the need to standardise on the types of aircraft being produced, but a decision was made to continue with the P.92/2. That aircraft made its first flight in the spring of 1941 and continued to fly for an extended period but it was scrapped before the end of the war. When F.11/37 was suspended, its turret development was also connected to the B.1/39 heavy bomber described in Chapter 6.

Specification F.18/40

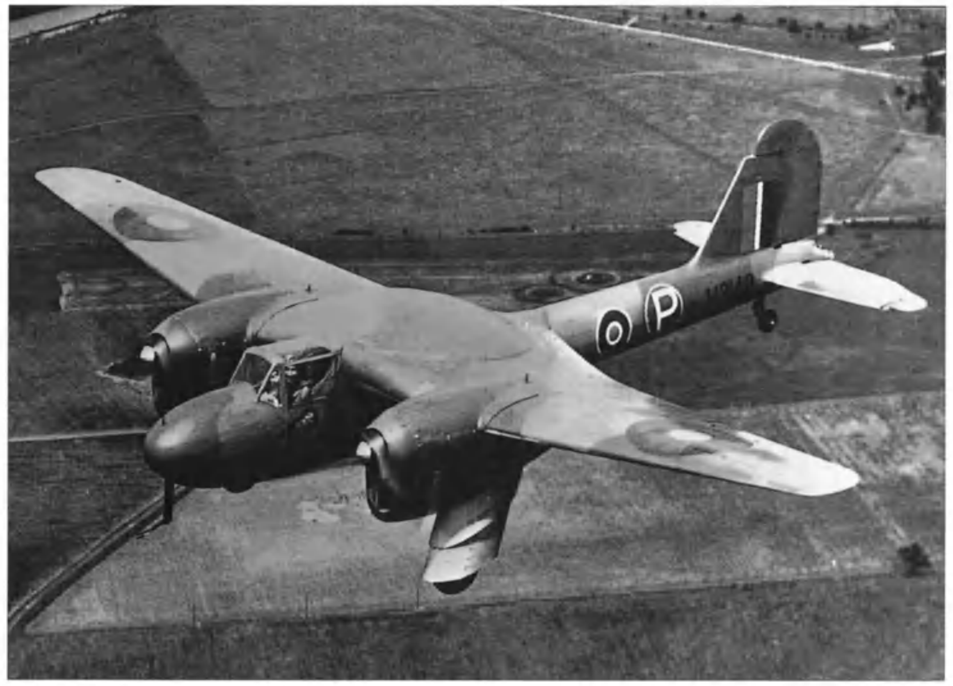
On 10th July 1940 Sholto Douglas (DCAS) wrote 'the problem of the night fighter is still far from being solved. The Blenheim is too slow and the pilot's view is bad. The [fixed-gun] Beaufighter may possibly provide the solution but at present it is a not very promising night fighter.' At the time, Air Marshal Joubert and others felt that proper night fighter armament was fixed forward 20mm cannon for stern attack and a 0.303in (7.7mm) Browning turret for attack from below with the target silhouetted against the sky. The Douglas Havoc was also being developed for night fighting but this aircraft was slow and looked on as no more than a stopgap. Sholto Douglas suggested that they should put out an Air Staff requirement for an aeroplane specif-



A model of the 'Small' Bristol F.11/37. Jim Oughton



This model of the Boulton Paul P.92, one presumes in the form the aircraft was to be built, is not in good condition and has lost its cockpit canopy, but it does show the fighter's layout well.



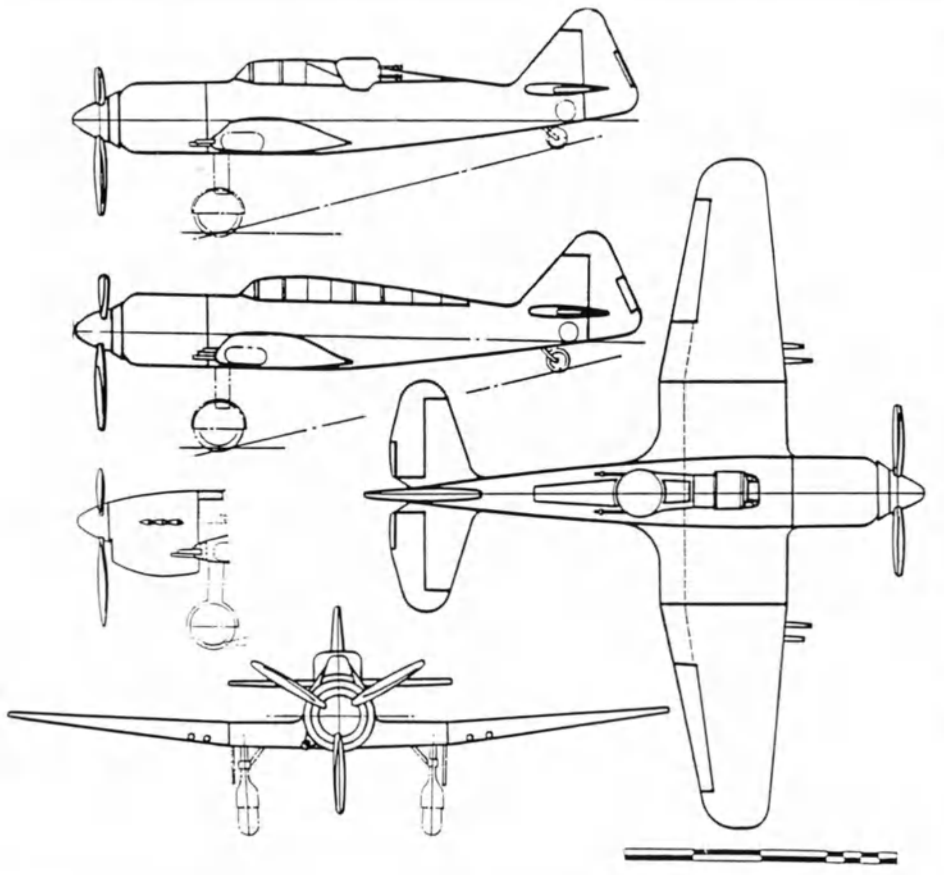
The scale-model P.92/2. Alec Brew (Boulton Paul Association) ically designed as a night fighter – it would have to be a two-seater and carry air-interception (AI) radar.

When the Luftwaffe's night bombing Blitz began in the autumn of 1940 the need for a new night fighter became ever more important and one result was the confirmation of Specification F.18/40, dated 31st October 1940, which called for a fixed-gun (six cannon) two-seat night fighter that was to be produced very quickly. Single or twin-engined types would be considered but performance was paramount with top speed at least 380mph (611km/h) at 20,000ft (6,096m). On 9th December the armament was amended to include a dorsal power-operated turret.

The discussions preceding this document were considerable since night fighting was essentially a new art, particularly with the need to carry AI radar. On 2nd October Squadron Leader Leatheart of Air Tactics explained some of the problems to the Deputy Director of Operational Requirements. He maintained that unless there was a quarter moon or more, the pilot of a night flying aeroplane spent his entire time concentrating on his instruments and could not do any searching. 'For all of the good he is doing he might just as well be in the officers mess having a nice beer.' Leatheart suggested the fitting of an automatic pilot but, clearly, there was much to learn. However, in November invitations to tender to F.18/40 were sent to Hawker, Gloster, Supermarine and Westland; requests for permission to tender were received from Boulton Paul and Fairey.

Boulton Paul P.96

A single-engine design similar to and scaled up from the Defiant, this used many components that were identical to the Defiant and there were five versions. The first three all had a Napier Sabre – P.96A had no turret but six forward-firing 20mm in the wings and a long canopy to cover the AI radar operator, B had a standard Defiant turret and two wing-mounted 20mm, C had the turret and a slightly larger wing with four 20mm; in B and C the pilot operated the radar. The other pair (oddly the brochure called both P.96D) kept the larger wing but used a Bristol Centaurus, the first with no turret and six cannon, the second with a turret and four wing cannon. All had two crew and, apart from P.96A at 32,200ft (9,815m), offered a ceiling of 35,000ft (10,668m) or slightly more. The P.96 represented Boulton Paul's main tender to F.18/40.



Boulton Paul P.97

This twin-Sabre type had a short central fuselage and two tail booms and came in two versions, with and without a turret. P.97A had six 20mm cannon mounted in a fuselage weapon bay while the P.97B had the turret and two nose cannon. The design allowed some of the fixed guns to be removed and replaced by two 550lb (249kg) bombs to provide an alternative use for the aeroplane. Engines of lower power than the NS.6.SM (which had a three speed supercharger) had not been considered because of the need to keep the performance competitive with enemy aircraft. Rate of climb at sea level was estimated to be 3,520ft/min (1,073m/min) for P.97A and 3,560ft/min (1,085m/min) for B, time to 20,000ft (6,096m) 6.7 and 6.6 minutes, service ceiling (for both) 39,500ft (12,040m). Internal fuel totalled 520gal (2,364lit).

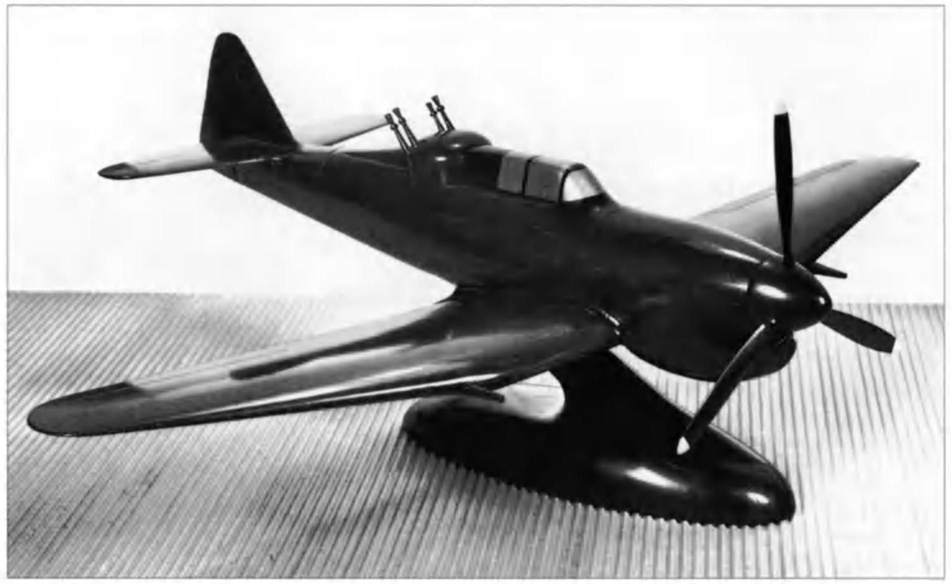
Fairey F.18/40

This two-seat Griffon-engined scheme was based on the Fleet Air Arm's Firefly (Chapter 10) with very little alteration except to the equipment; there was no turret. Fairey stressed the difficulty of introducing a completely new design under the present conditions and considered that it would be impracticable to accommodate both fixed cannon and an interchangeable four-gun turret, plus the AI operator, in a single-engined aircraft. It therefore offered a direct derivation from the N.5/40 Firefly in which that design was maintained except for the addition of two extra cannon, the necessary strengthening of the undercarriage, wing and body and the elimination of FAA features such as wing folding, catapult and arrester gear. Estimated ceiling was 30,500ft (9,296m).

Gloster F.18/40

This development of the F.9/37 fighter (Chapter 2) had twin Merlin XX engines replacing the Taurus, which substantially increased the type's range, endurance and military load. At an all-up-weight of 14,500lb (6,577kg), the designers felt that an effective limit of development had been reached and to meet F.18/40 in full would need a weight in excess of 15,000lb (6,804kg) with another 60ft^2 (5.6m^2) of wing area; however, all of the operational requirements for a night fighter had been met here except that four cannon were carried instead of six (beneath the cockpit). Time to 10,000ft (3,048m) and 25,000ft (7,620m) was estimated to be 3.8 and 11.4 minutes respectively, ceiling 35,500ft (10,820m). Gloster's modified F.9/37 was accepted as the company's tender to F.18/40 but because it did not meet all of the requirements a special specification, F.29/40, was eventually drawn up to cover it.

Boulton Paul P.96 (both Sabre and Centaurus engine) with and without turret (c11.40). Les Whitehouse



Model of the P.96B. Alec Brew (Boulton Paul Association)

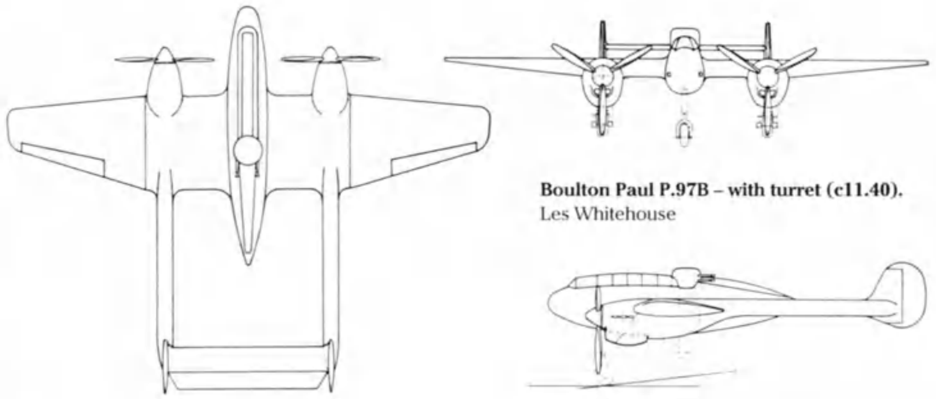
Hawker P.1008

This night fighter to F.18/40 is another Hawker design for which no information has been found. In fact Hawker did not tender to F.18/40 (neither did Supermarine or Westland).

Two other designs were also prepared to F.18/40 but were not tendered.

Miles M.22

This was a development of Miles' M.22 fighter project with two Merlin XX or Merlin 60 engines mounted in narrow wing nacelles and served by ducted radiators in the wing. It was comparable in size to the Mosquito, had four 20mm guns mounted in the upper nose and was built entirely of wood; an alternative version had a Boulton Paul four-gun turret. The Merlin XX gave an absolute ceiling of 40,000ft (12,192m) while the Merlin 60 series pushed this up to 43,000ft (13,106m).



Boulton Paul P.97B – with turret (c11.40). Les Whitehouse

Vickers F.18/40

On 16th October 1940 a near identical version of the Vickers Type 420 to F.16/40 (Chapter 2) was proposed to the draft F.18/40, except for a switch to Merlin XX engines. In January 1941 a new Merlin XX F.18/40 was proposed as a three-seat night fighter with two fixed 20mm Hispanos plus four 0.303 (7.7mm) Browning machine guns in a power-operated turret located in a fairing on top of the amidships fuselage. This would be remotely controlled by a gunner seated alongside the pilot and the turret guns could be elevated up to 45° and turned 60° to either side, subject to some restrictions from the airscrews; the 20mm guns were located in the bottom fuselage.

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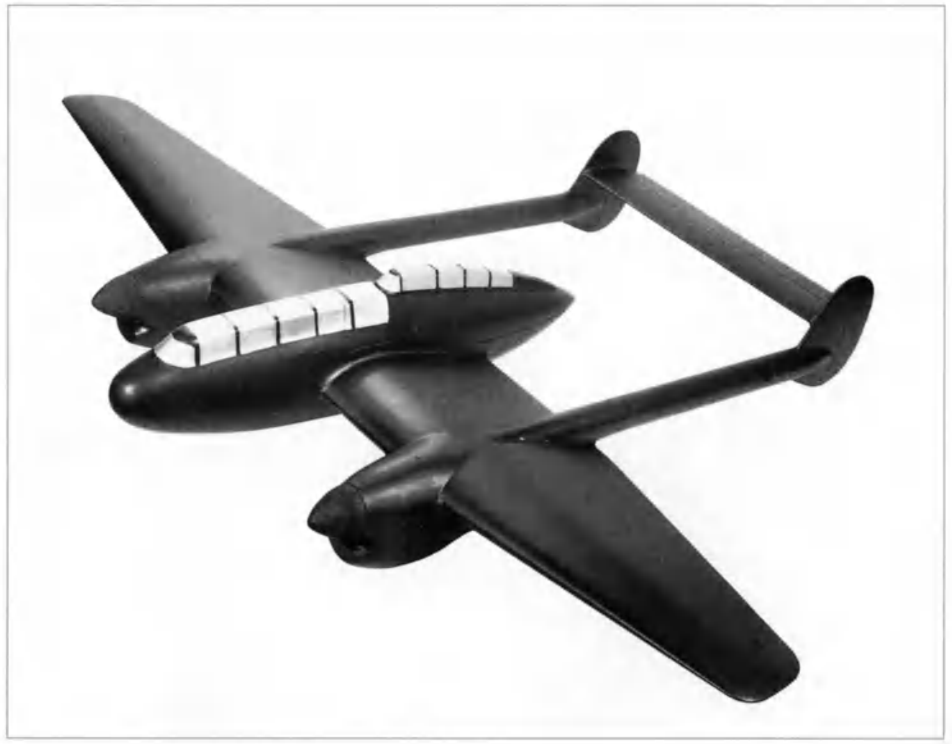
F.18/40 actually raised two separate lines of research, the Gloster F.9/37 development and the alternative studies to F.18/40. Gloster's design was unofficially christened Reaper. This project had started in around June 1940, prior to F.18/40 being formulated, and fitting



Model of the P.97A. Alec Brew (Boulton Paul Association)

Merlin XXs in the airframe was seen to be a relatively small job. The two-seat night fighter was proposed to W S Farren, DTD, on 8th July and, with Merlin XXs and a strengthened airframe, was looked upon as a particularly attractive idea that would nearly meet the Air Staff's requirements. On 23rd September Sir Henry Tizard, AMDP, noted that the F.9/37 had shown very good handling and flying characteristics and he felt that any night fighter proposals from other manufacturers were unlikely to be appreciably superior to it. On 13th October go-ahead was given to convert one of the F.9/37s to F.18/40 and a cockpit mock-up was examined on 26th October.

However, by December it was apparent that it would not be possible to get a reasonable number of F.9/37s, or F.18/40 Reapers, until the end of 1942; Joubert felt that it would be out of date by the time it came into production while Mr Hennessy wrote that it was not sufficiently promising as a production job to be worth the effort of development. On 1st December the Secretary of State for Air requested that the Reaper should proceed because production facilities, capacity and materials would have to be allocated in the next few months.

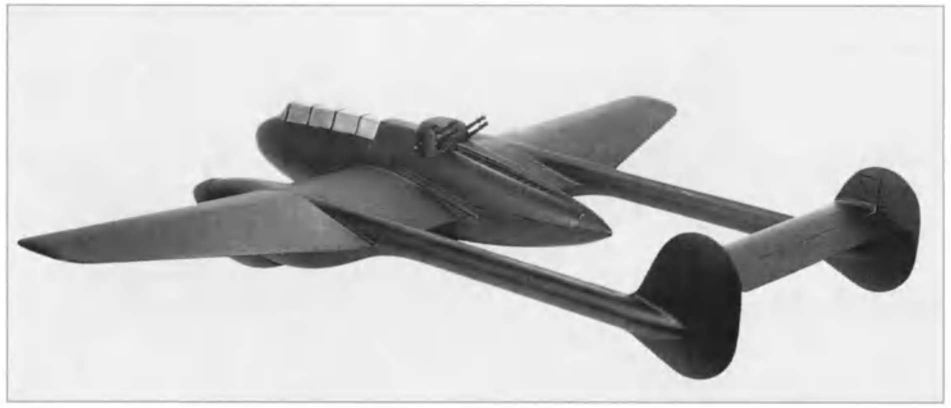
A MAP meeting, including Tizard, Farren and DGRD, was held on 18th December to discuss the type. The Air Staff wanted the Reaper because it was considered to be better than the Beaufighter but MAP preferred Gloster to go easy on the Reaper and concentrate on its jet fighter (Chapter 11). This meant that the Beaufighter would have to be developed as an insurance against the failure of the Whittle jet because de Havilland had stated that fitting the Mosquito with a turret would mean a radical redesign of that aircraft. Bristol had also declared that installing a turret in the Beaufighter would present difficulties and that its speed would be appreciably reduced. The meeting agreed to recommend to the Air Staff that the Reaper should immediately go on to a lower priority, but that it should not be entirely suspended.

Gloster's chief designer, George Carter, felt that the Reaper would not be in production within 18 months and stated that he did not have enough design staff to undertake it and the jet project. Twelve days later Geoffrey de Havilland was asked if a night fighter version of the Mosquito could be quickly produced to the latest requirements. Tizard felt that this would allow Gloster to stop work on the Reaper because he was anxious to see the company concentrate on its heavy commitments for Whittle-engined jet fighters, although he thought the Reaper with Merlin XXs was the best night fighting aircraft that could be expected and, had Gloster not been so involved with the jet, he would have recommended that it should continue. On 1st May 1941 both MAP and the Air Staff finally agreed that the Gloster Reaper should not proceed further and that de Havilland's Mosquito would be considered to fill the night fighter requirement.

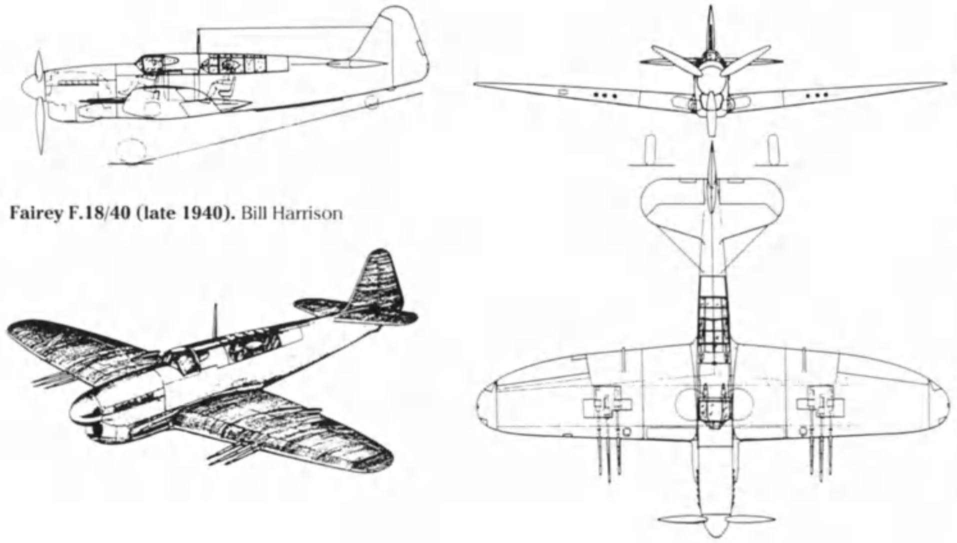
Turning to the other F.18/40 designs, on 24th March 1941 Capt R N Liptrot completed an appraisal and estimated that the P.96 would be at least 1,000lb (454kg) heavier than Boulton Paul had claimed but its performance estimates were reasonable; he also felt that the P.97 had no merits for a night fighter and introduced severe structural problems. The Fairey project did not conform to the new requirements of F.18/40 (that is, no turret) but substantially satisfied the document in its original form. However, its speed and ceiling were both low and, in spite of the ease of production, the type was unacceptable. In conclusion he felt that none of the submitted designs were considered to be really acceptable, although the P.96 was a not unreasonable interpretation of the specification as issued, and suggested that the Air Staff should reconsider the present requirements. N E Rowe agreed and added 'I think it is true to say that we know very much more about night fighting requirements now than we did when F.18/40 was drafted'.

On the 28th Farren added that Fairey's project did not attempt to meet the turret requirement and, although its take-off and landing were reasonable, its speed and ceiling were indeed not up to specification (the engine power was inadequate for the load). Boulton Paul's P.96 gave a good performance with the high-altitude Sabre NS.6.SM but the landing run was too long. The P.97 gave a higher performance but there seemed to be little advantage in the twin-boom arrangement. Farren confirmed that none of these proposals was suitable to meet the requirements that were now emerging and maturing from operational experience.

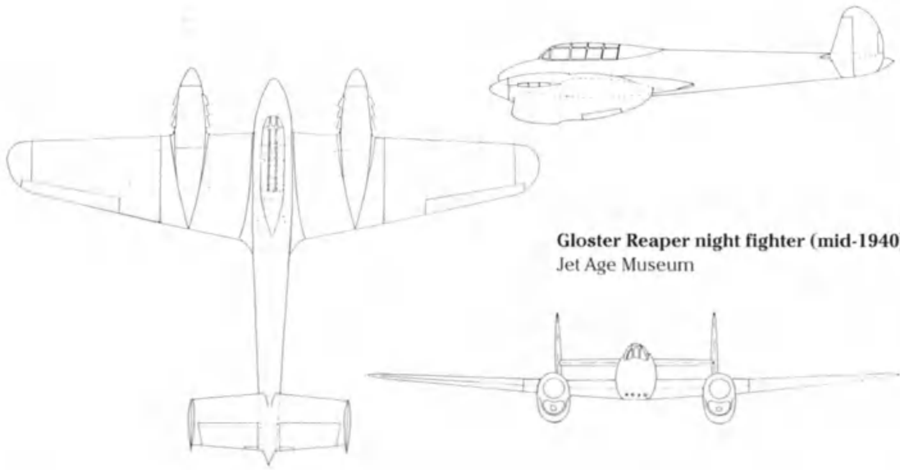
Both Boulton Paul and Fairey were told by Farren on 11th April that no aircraft was to be ordered to F.18/40. The requirements were continuously under review and a new specification was being considered in terms of night fighter technique and the possible adoption of existing types. In due course the need for a night fighter was met by the Bristol Beaufighter and the de Havilland Mosquito, both of which had fixed guns, while the key to night fighting was to be the carriage of AI radar, not turrets. Nevertheless two Merlin Mk.II Beaufighters, R2274 and R2306, were fitted with a Boulton Paul dorsal turret with four 0.303in (7.7mm) guns, but the conversion took time and by 28th January 1941 only the aperture had been cut into the skin of the first example; work was expected to be completed in mid-April with the type in production by August as the Beaufighter Mk.V. R2274 was tested briefly at A&AEE around early summer 1941 and the turret was found to operate satisfactorily even in dives up to 390mph (628km/h). The aircraft weighed 18,695lb (8,480kg) and with the turret facing aft gave a top speed of 302mph (486km/h) at 19,300ft (5,883m), but the variant was not adopted.



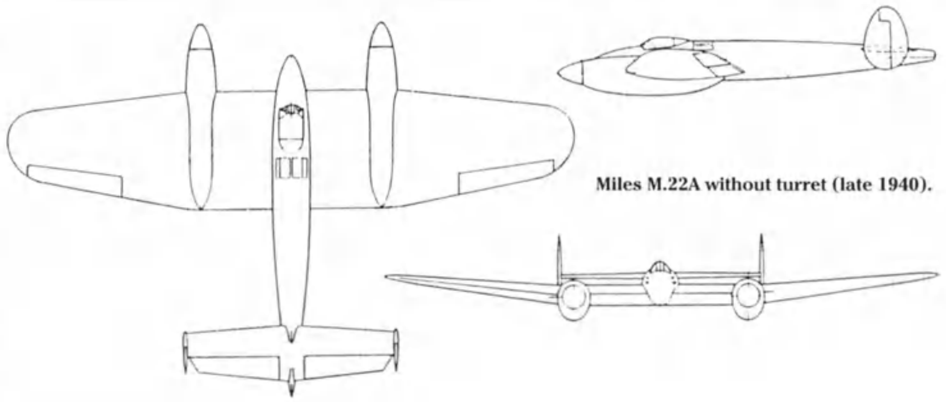
Model of the P.97B. Alec Brew (Boulton Paul Association)



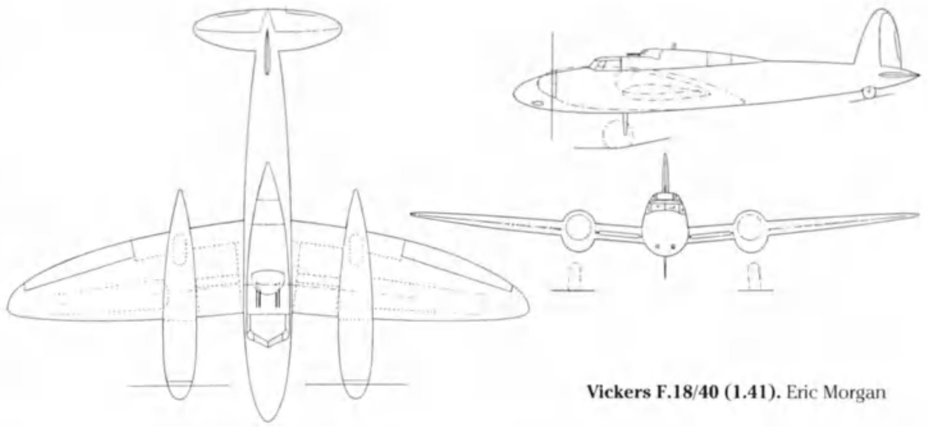
Fairey F.18/40 (late 1940). Bill Harrison



Gloster Reaper night fighter (mid-1940). Jet Age Museum

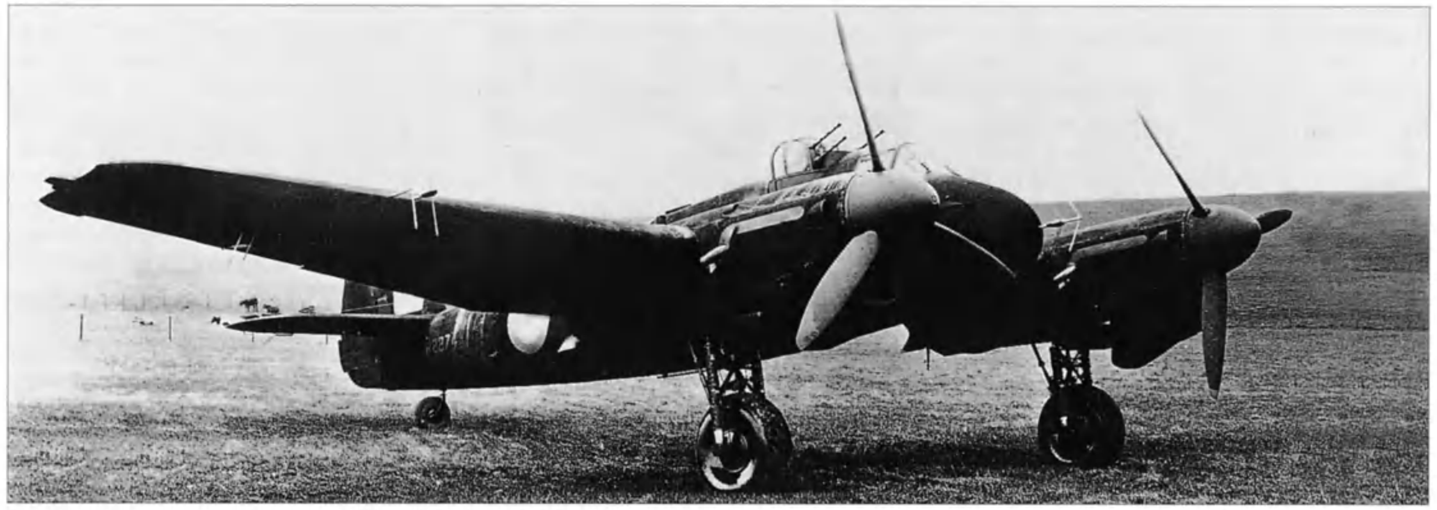


Miles M.22A without turret (late 1940).



Vickers F.18/40 (1.41). Eric Morgan

Bristol Beaufighter R2274 seen during testing at Boscombe Down in May 1941 with a dorsal turret fitted. David Charlton, BAe Filton

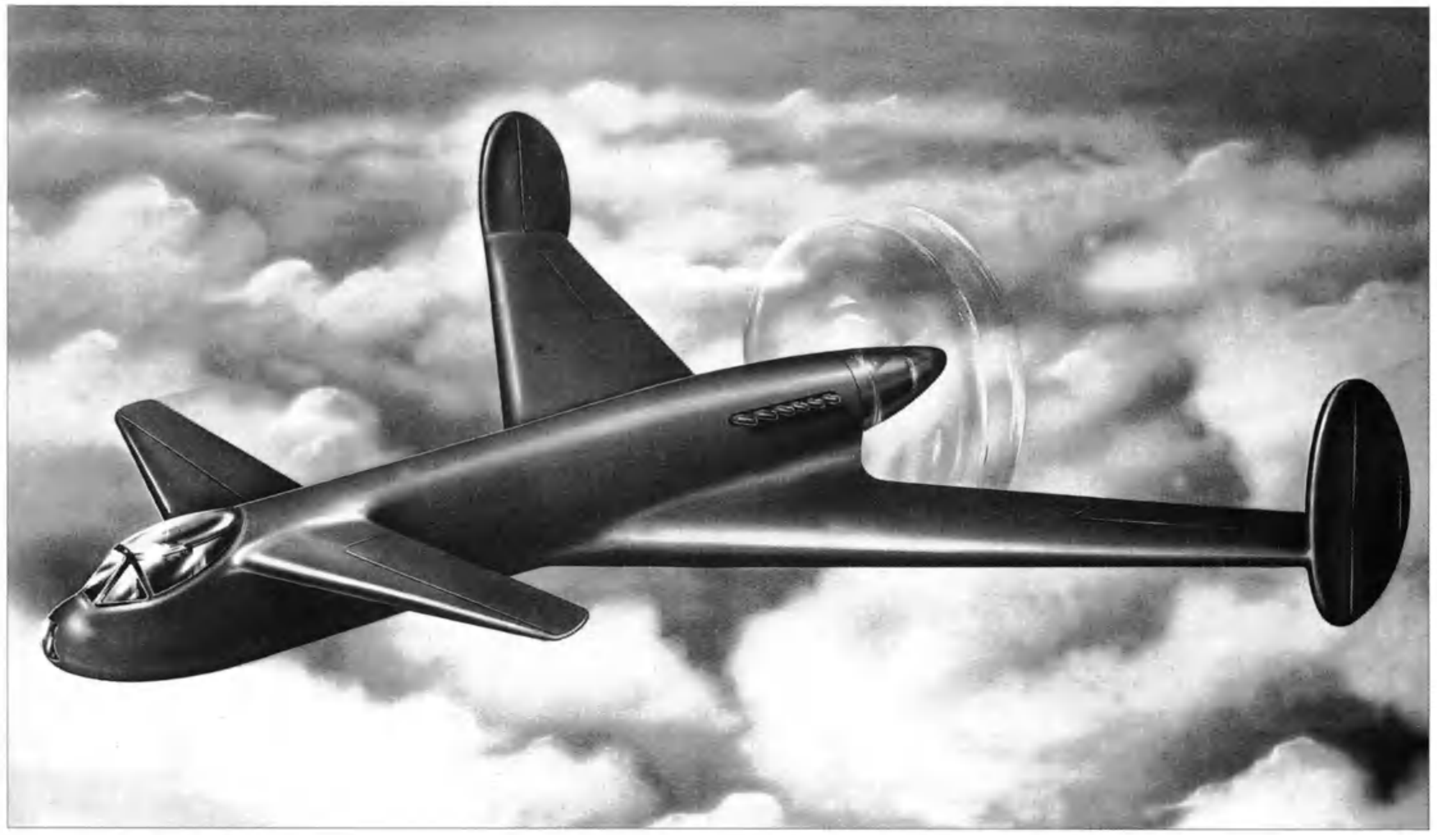


Turret Fighters – Estimated Data

Project	*Span* *ft in (m)*	*Length* *ft in (m)*	*Gross Wing Area* *ft² (m²)*	*Max Weight* *lb (kg)*	*Engine* *hp (kW)*	*Max Speed / Height* *mph (km/h) / ft (m)*	*Armament*
Specification F.9/35							
AWA F.9/35	39 0 (11.9)	37 3 (11.4)	259 (24.1)	6,700 (3,039)	2 x Terrier	328 (528)	4 x 0.303in (7.7mm) mg
Boulton Paul P.82	39 0 (11.9)	33 0 (10.1)	240 (22.3)	5,771 (2,618)	1 x Merlin F.5	323 (520) at 15,000 (4,572)	4 x 0.303in (7.7mm) mg
Bristol 147	40 0 (12.2)	30 0 (9.1)	?	?	1 x Perseus or Hercules	280 (451) or 315 (507) at 15,000 (4,572)	4 x 0.303in (7.7mm) mg
Fairey F.9/35	No data available						
Gloster F.9/35	No data available						
Hawker F.9/35	45 6 (13.9)	33 2 (10.1)	260 (24.2)	?	1 x Merlin C	?	4 x 0.303in (7.7mm) mg
Supermarine 305	37 0 (11.3)	30 6 (9.3)	242 (22.5)	5,650 (2,563)	1 x Merlin 1,000 (746)	315 (507) at 15,000 (4,572)	4 x 0.303in (7.7mm) mg
Boulton Paul Defiant Mk.I (flown)	39 4 (12.0)	35 4 (10.8)	250 (23.3)	8,240 (3,738)	1 x Merlin III 1,030 (768)	304 (489) at 17,000 (5,182)	4 x 0.303in (7.7mm) mg
Hawker Hotspur (flown)	40 6 (12.3)	32 10.5 (10.0)	265 (24.6)	6,850 (3,107)	1 x Merlin 2 1,025 (764)	320 (515)	4 x 0.303in (7.7mm) mg (not fitted)
Specification F.11/37							
AWA F.11/37	43 0 (13.1)	43 3 (13.2)	?	13,500 (6,124)	2 x Merlin	418 (673)	4 x 20mm cannon
Boulton Paul P.92	62 6 (19.1)	52 3 (15.9)	650 (60.5)	17,697 (8,027)	2 x Vulture II 1,710 (1,275)	371 (597) at 15,000 (4,572)	4 x 20mm cannon
Bristol F.11/37 'Small'	59 0 (18.0)	38 8 (11.8)	478 (44.5)	14,310 (6,491)	2 x Hercules HE.2.SM	370 (595) at 15,000 (4,572)	4 x 20mm cannon
Bristol F.11/37 'Large'	65 0 (19.8)	42 3 (12.9)	590 (54.9)	17,680 (8,020)	2 x 'Centaurus' 2,000 (1,491)	390 (628) at 15,000 (4,572)	4 x 20mm cannon
Gloster F.11/37	63 0 (19.2)	45 6 (13.9)	565 (52.5)	17,100 (7,757)	2 x Vulture	378 (608) at 15,000 (4,572)	4 x 20mm cannon or 2 x 23mm cannon
Specification F.18/40							
Boulton Paul P.96A	44 (13.4)	38 (11.6)	325 (30.2)	12,660 (5,743)	1 x Sabre NS.6.SM 2,300 (1,715)	410 (660) at 34,000 (10,363)	6 x 20mm cannon
Boulton Paul P.96C	46 (14.0)	38 (11.6)	340 (31.6)	12,680 (5,752)	1 x Sabre NS.6.SM 2,300 (1,715)	400 (644) at 34,000 (10,363)	4 x 20mm cannon, 4 x 0.303in (7.7mm) mg
Boulton Paul P.96D	46 (14.0)	38 (11.6)	340 (31.6)	12,306 (5,582)	1 x Centaurus CE.4.SM 2,300 (1,715)	400 (644) at 22,500 (6,858)	4 x 20mm cannon, 4 x 0.303in (7.7mm) mg
Boulton Paul P.97A	58 6 (17.8)	45 6 (13.9)	?	19,586 (8,884)	2 x Sabre NS.6.SM 2,300 (1,715)	425 (684) at 34,000 (10,363)	6 x 20mm cannon
Boulton Paul P.97B	58 6 (17.8)	45 6 (13.9)	?	19,232 (8,724)	2 x Sabre NS.6.SM 2,300 (1,715)	418 (673) at 34,000 (10,363)	2 x 20mm cannon, 4 x 0.303in (7.7mm) mg
Fairey F.18/40	c44 6 (13.6)	c37 7 (11.5)	?	?	1 x Griffon	370 (595) at 23,000 (7,010)	6 x 20mm cannon
Gloster Reaper	50 0 (15.2)	37 10 (11.5)	386 (35.9)	14,500 (6,577)	2 x Merlin XX	390 (628) at 22,500 (6,858)	4 x 20mm cannon
Miles M.22A	51 0 (15.5)	35 0 (10.7)	460 (42.8)	16,500 (7,484)	2 x Merlin XX or 2 x Merlin 60	405 (652) at 22,500 (6,858) 425 (684) at 29,750 (9,068)	4 x 20mm cannon
Vickers F.18/40 (1.41)	54 0 (16.5)	43 10 (13.4)	403 (37.4)	15,585 (7,069)	2 x Merlin XX 1,270 (947)	409 (658) at 24,000 (7,315)	2 x 20mm cannon, 4 x 0.303in (7.7mm) mg
de Havilland Mosquito F Mk.II (flown)	54 2 (16.5)	41 2 (12.5)	454 (42.2)	18,547 (8,413)	2 x Merlin 21 1,460 (1,089)	370 (595) at 14,000 (4,267)	4 x 20mm cannon, 4 x 0.303in (7.7mm) mg

Chapter Four

Light Bombers and Ground Attack

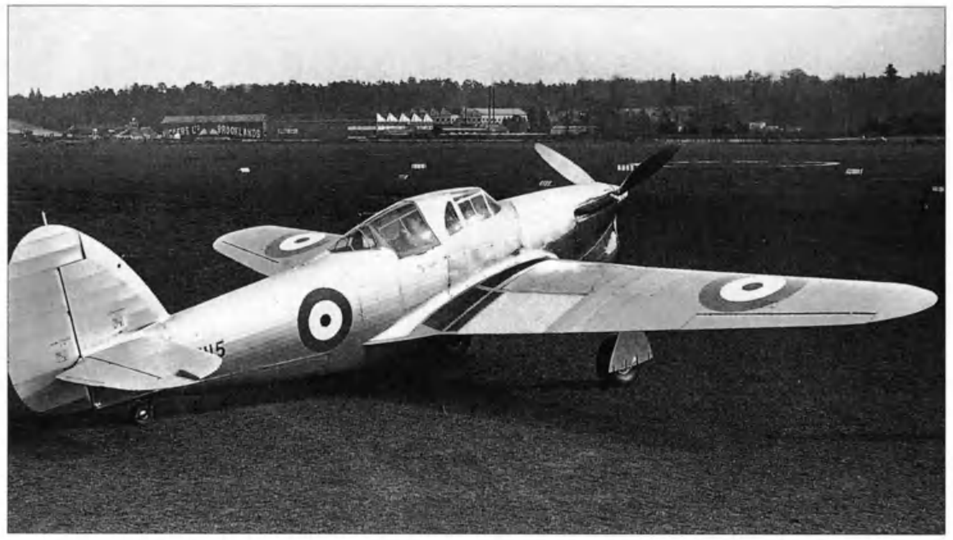


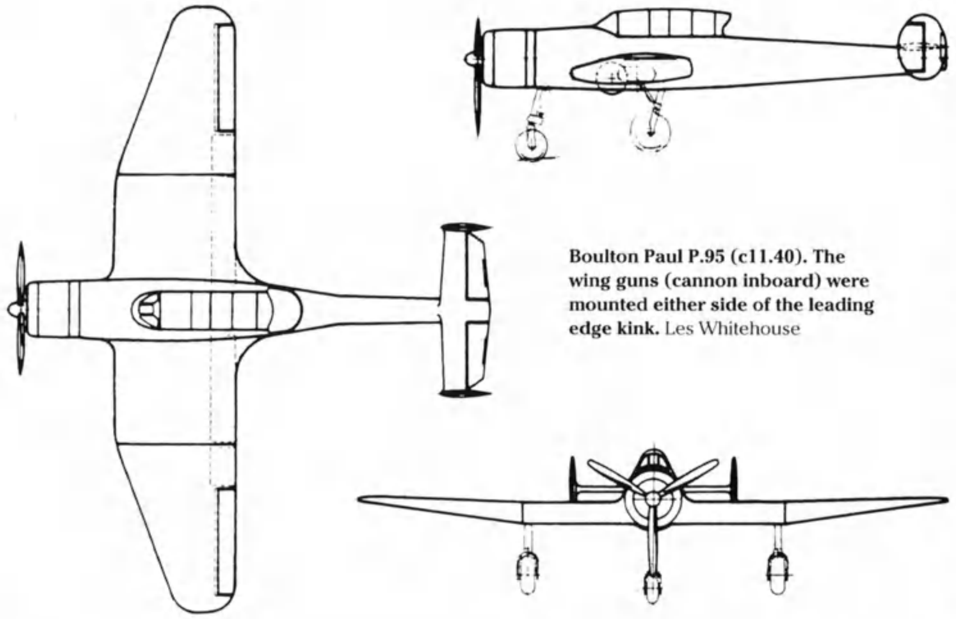
Artist's impression of the P.100. Alec Brew (Boulton Paul Association)

During the early 1930s Britain assumed that the most likely enemy in any future war would be France and several new military aircraft were developed with this in mind. The aeroplanes most influenced by this theory were some new bomber designs intended to replace types already in service. These included the Handley Page Hampden and Vickers Wellington medium day bombers (both originally developed to Specification B.9/32 although they entered service in much modified form) and the Fairey Battle light day bomber. The Battle was produced to P.27/32 and by the beginning of the war was serving in quantity with the RAF. The day bomber was considered to be one of the prime elements of Britain's main striking force against France and, as Colin Sinnott notes, the distance to Paris was taken as the criterion for its range.

After the outbreak of war some British forces, including squadrons of Battles, were sent to France but, when the Germans invaded in 1940, the Battles were found to be outclassed against the Luftwaffe's fighters and were shot down in large numbers. These events signalled the end of the light day bomber as a prime element in Britain's forces and so the type does not feature very much in this book. As the war progressed a new type appeared which partially filled the gap left by the light bomber, the ground attack aircraft. The conflict's 'fast moving' battles with tanks and armoured vehicles required specialist aircraft to deal with them and, from the RAF's point of view, the task was to be largely filled by variants of the Hawker Hurricane, Typhoon and Tempest fighters. However, in 1942 and 1943 the first efforts were made by industry to produce a dedicated ground attack aircraft and these are featured later in the chapter.

At the start of World War Two the RAF did not believe in ground attack; it felt that the battlefield was not the place for aeroplanes and specific types dedicated to the ground attack and close-support roles fell outside RAF doctrine. The Service did have some Army co-operation types, such as the Westland Lysander, but considered that combat aircraft were better used for interdiction, which is why the RAF used types like the Blenheim and Battle and not equivalents to the German Junkers Ju 87 dive bomber and Ju 88 multi role-aircraft. The British Army disagreed and put considerable pressure on the RAF to change and eventually, by the time of the D-Day landings, the RAF had moved on to close air support with aircraft like the Typhoon. The key to ground attack operations is air superiority, which basically allows the operation of any other type of aeroplane over the battlefield.





Boulton Paul P.95 (c11.40). The wing guns (cannon inboard) were mounted either side of the leading edge kink. Les Whitehouse

Specification B.20/40

After the Fairey Battle, the next major day bomber specification was P.4/34 which was issued to tender on 12th November 1934 and met by two prototypes, the Fairey P.4/34 and the Hawker Henley. The former followed the Battle's basic form and first flew on 13th January 1937 but it remained a prototype although one example, K5099, was modified in March 1938 with a smaller span and raised tailplane to act as a flying mock-up for the Fairey Fulmar fleet fighter to O.8/38 (Chapter 10). The Hawker Henley, another type closely related structurally to the Hurricane, flew on 10th April 1937 and was ordered into production, but the Air Ministry's already shifting philosophy towards the light bomber brought changes to the requirements and the type was eventually used as a target tug.

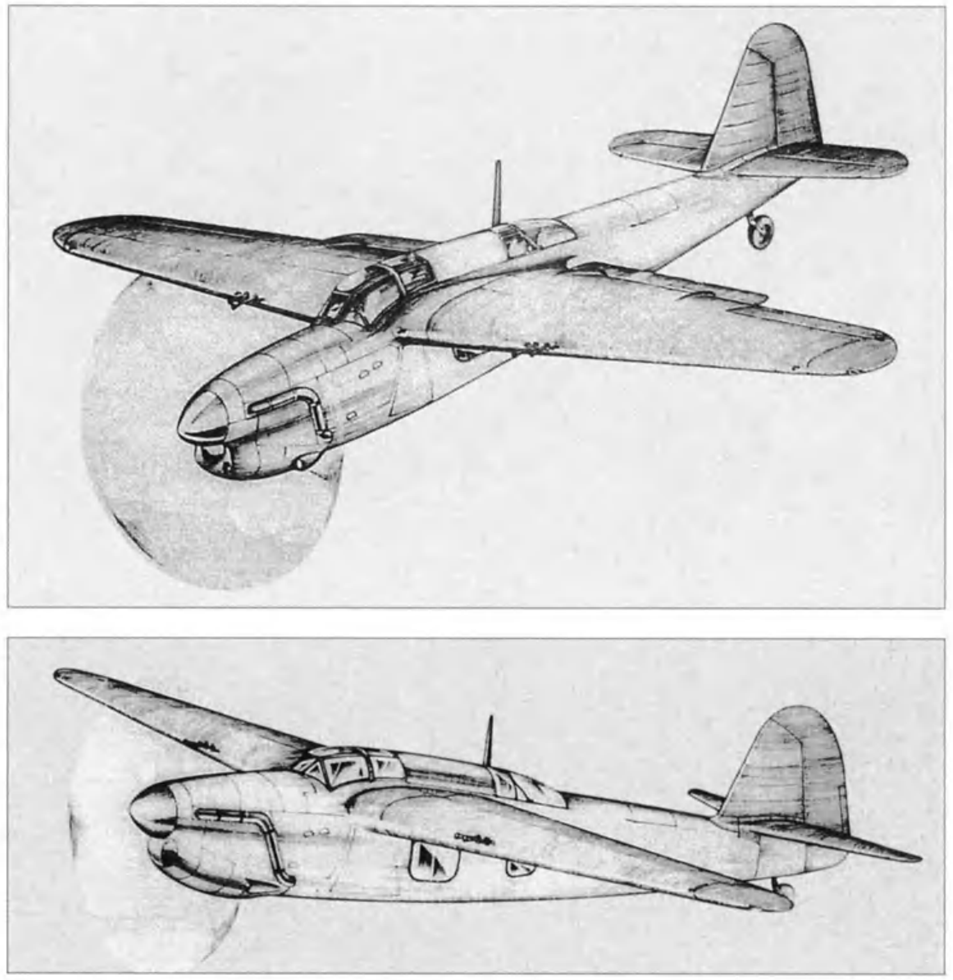
The final effort to produce a light bomber was Specification B.20/40 of 1940 although, signifying the changes in thinking that had been made, this document actually called for a Close Army Support Bomber. The document requested a high speed (280mph [451km/h] at 5,000ft [1,524m]) using a Merlin engine, plus dive bombing and a photo reconnaissance capability. Boulton Paul, Fairey and Hawker are known to have responded and a design from Westland was prepared which appears also to have been to B.20/40, despite being rather later in timescale.

Boulton Paul P.95

This two-seat bomber was powered by a Hercules VI (HE.6.SM) or a Griffon. It had a low straight wing with a parallel chord centre section, but sweepback on the outer wing leading edge to assist in dealing with wire barrages, and also featured twin fins and rudders to keep the field of fire clear to deal with an attack from astern. There was a long canopy over the pilot and his gunner although the rear was left open for the latter's ring-mounted twin 0.303in (7.7mm) Browning machine guns. One fixed forward-firing Hispano 20mm cannon and four more Brownings were housed in each wing while the fuselage and wing bomb bays could each hold one 250lb (113kg) bomb; the aircraft had a tricycle undercarriage. The crew were seated close together but the brochure acknowledged that this arrangement was not so satisfactory, from the point of view of rear defence, as when placing the gunner in the tail. The gunner was also able to get shots vertically downwards to each side of the rear fuselage. With the Hercules maximum rate of climb was 1,620ft/min (494m/min) at 5,000ft (1,524m) and service ceiling 27,500ft (8,382m); equivalent figures for the Griffon were 1,825ft/min (556m/min) at 5,000ft and 30,000ft (9,144m). The aircraft's speed in a 60° dive, with flaps set at 90°, was not to exceed 300mph (483km/h).

Fairey Battle light bombers flying in line abreast.

Hawker Henley prototype K5115.



Artist's impressions of the Fairey B.20/40 (late 1940).

Fairey B.20/40

Fairey stated that three main characteristics of B.20/40, high speed, good view (especially downwards) and dive bombing, were all met by the existing Barracuda (Chapter 9) and so the tender offered that aeroplane suitably modified to meet the requirements. The requested 280mph (451km/h) was not thought possible with a Merlin (the most suitable powerplant) but this new design 'was small and as cleanly designed as possible' and its estimated 265mph (426km/h) was considered by Fairey to be a reasonable achievement. The high mid-wing gave an exceptionally wide field of view for the crew, both above and below, and was equipped with external flaps which would be adjusted to positive angles for take-off and landing and to negative angles for braking in a dive bombing attack. This type of flap, developed full-scale on the Fairey P.4/34, had the advantage of comparatively light pitching moments in the dive and did not result in an excessively turbulent wake over the tail.

Except for the simplification brought by the removal of naval fittings, the B.20/40's structure was identical to the Barracuda's. Wing construction was light alloy throughout, a stressed skin reinforced with transverse stringers being used to cover two main spars and the ribs, but the ailerons were fabric covered. The extreme forward and rear portions of the fuselage, including the engine mounting, used a tubular metal structure but the remainder was composed of light alloy monocoque. The fin and tailplane were made of stressed skin built up on cantilever spars. Armament comprised four 0.303in (7.7mm) machine guns firing forward, two more facing rearwards plus bombs, and 195gal (887lit) of internal fuel were carried. The aircraft would take 3.5 minutes to reach 5,000ft (1,524m) and 17.83 minutes to 20,000ft (6,096m), service ceiling was 25,500ft (7,772m) and range with normal load 500 miles (805km).

Hawker P.1006

Hawker also offered a modification of an existing design, the Henley. No detailed information survives but the drawing shows few changes from the original Henley except for a more powerful RM.5.SM Merlin; span was unchanged and length only slightly more. Two 0.303in Brownings were housed in the rear cockpit and another pair in the middle of each wing, and two 250lb (113kg) bombs were carried in a fuselage bay beneath the pilot with one more under each wing.

Westland B.20/40

This dive bomber project, a variant of Westland's B.7/40 design (Chapter 5) but without the Delanne wing, appears to have been created about six or seven months later than the above; some published sources credit it to B.20/40 but not Westland's own documents. It featured a Bristol Centaurus engine, a cannon under each wing and four machine guns in a rear cockpit turret.

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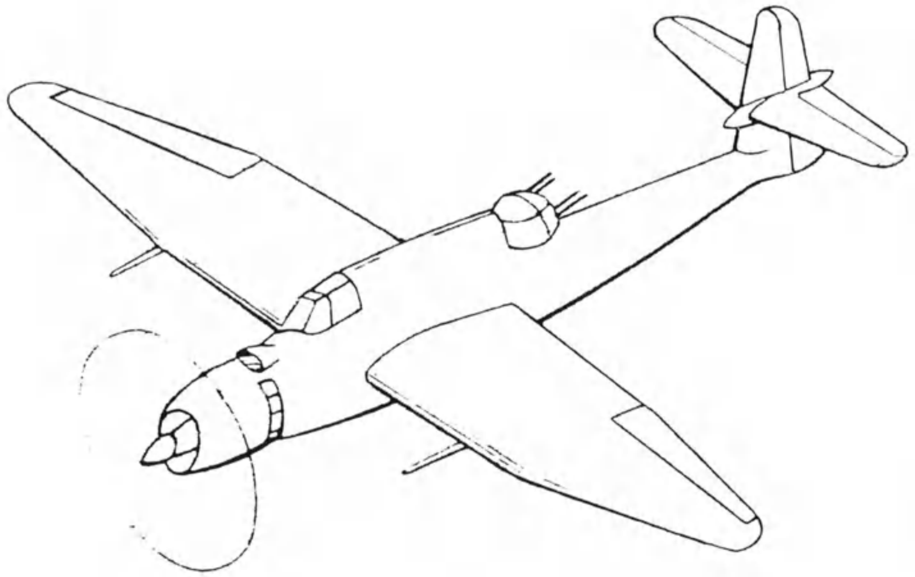
Specification B.20/40 was not proceeded with and none of these designs was accepted for construction.

Ground Attack

On 7th March 1942 a draft specification was raised, which never received a number, for a 'highly manoeuvrable single-seat low attack aircraft for employment against military forces on the ground, aircraft, invasion craft and shipping.' The aircraft's primary role was to be the destruction of tanks and similar targets and it was to replace the Hurricane Mk.IID (the IID was armed with two 40mm cannon and served as a ground attack 'tank-buster'). It was classed as an Army Direct Support Aircraft and was to carry more guns than the Hurricane, and of heavier calibre; the alternatives were three 40mm cannon, two 40mm cannon plus two 20mm cannon, four 20mm, two 20mm and six unguided rocket projectile (RP) racks or two 20mm with one Vickers 47mm (3.5lb [1.6kg]) gun. Provision was also to be made for two 500lb (227kg) bombs. The maximum speed had to be at least 280mph (451km/h) at 3,000ft (914m) and an excellent forward view was considered essential. This new type of aeroplane had to be in full-scale production by January 1944.



Sketch of the Westland dive bomber (6.41). Fred Ballam, Westland

Hurricane KZ198 was a Mk.IIC fitted with two 40mm cannon. Eric Morgan

On 25th March R N Liptrot completed an investigation identifying three possible types of aircraft that could fill this requirement – a twin-boom pusher with one Merlin 61 (top speed 195mph [314km/h], span 57ft [17.4m]), a twin-boom pusher with one Sabre III (223mph [359km/h], 65ft [19.8m]) or a normal twin-engined type with two Merlin 61 (225mph [362km/h], 70ft [21.3m]). Since this was a 'new' type of aircraft, there were various arguments suggesting what might actually be built – should the RAF continue with a Hurricane with 'heavy armament' or (as Wilfrid Freeman noted on 26th April) should it be an aircraft designed and built by one of the 'smaller' companies such as General Aircraft or Westland. A letter was sent to Airspeed, Armstrong Whitworth, Boulton Paul and Phillips & Powis on 15th August 1942 outlining the new requirement but Boulton Paul delayed its submission because of a lack of information on both RPs and the 47mm gun (which was not yet in existence). In the meantime a design was offered by Cunliffe-Owen.

Cunliffe-Owen Attack Aircraft

This brochure, submitted on 30th August, outlined four versions of the same aircraft:

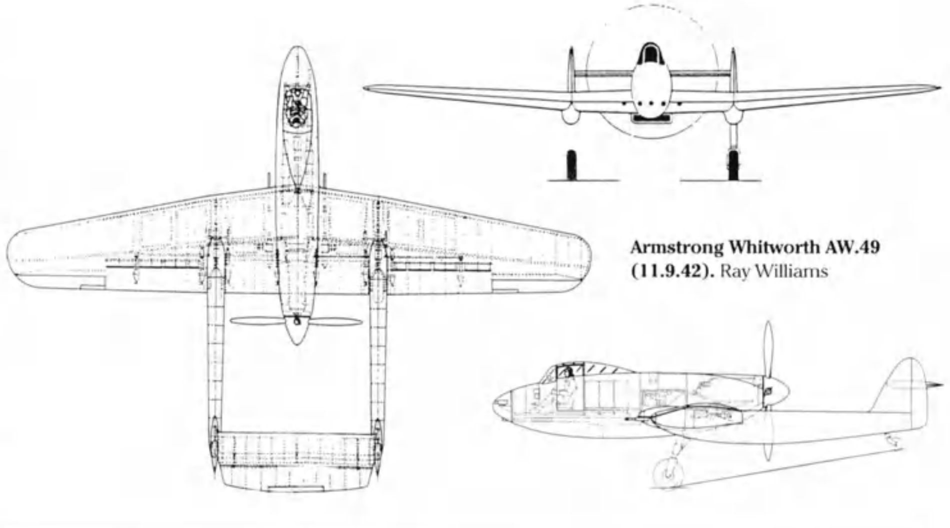
- No 1 carried thirty 0.303in (7.7mm) machine guns mounted at a fixed angle of depression,
- No 2 had nine 40mm cannon – seven in the aerofoil body at a fixed angle of depression and the other pair placed horizontally under the outer wings,
- No 3 was a version with three banks of four RPs,
- No 4 (to illustrate its versatility) was a dive bomber.

A big feature for 1 and 2 was that the pilot could fly straight across his target instead of diving onto it.

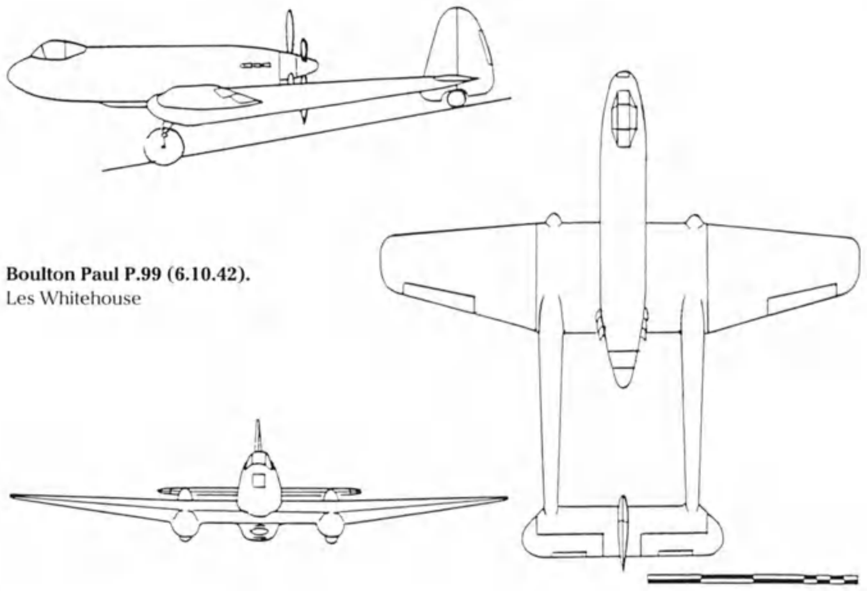
On 10th September R S Sorley commented that this design, from a sighting and technical point of view, was open to several objections but the combination of loads within an all-up-weight of 18,000lb (8,165kg) was interesting, if it was possible. Five days later N E Rowe, DTD, reported that it was unsuitable for ground attack because the angled-down guns gave insuperable sighting problems and technical limitations. There was strong support elsewhere for the Hurricane IID rather than this nine-gun design which, at 68ft (20.7m) span, was too big to be satisfactory in the low attack role. Cunliffe-Owen was informed as such on 18th September but was also asked to produce a design for the latest updated requirements for low attack aircraft. Three days later Airspeed, Armstrong Whitworth, Boulton Paul, Cunliffe-Owen and Phillips & Powis (which in October 1943 became Miles Aircraft) were officially invited to tender; only Airspeed did not.

Armstrong Whitworth AW.49

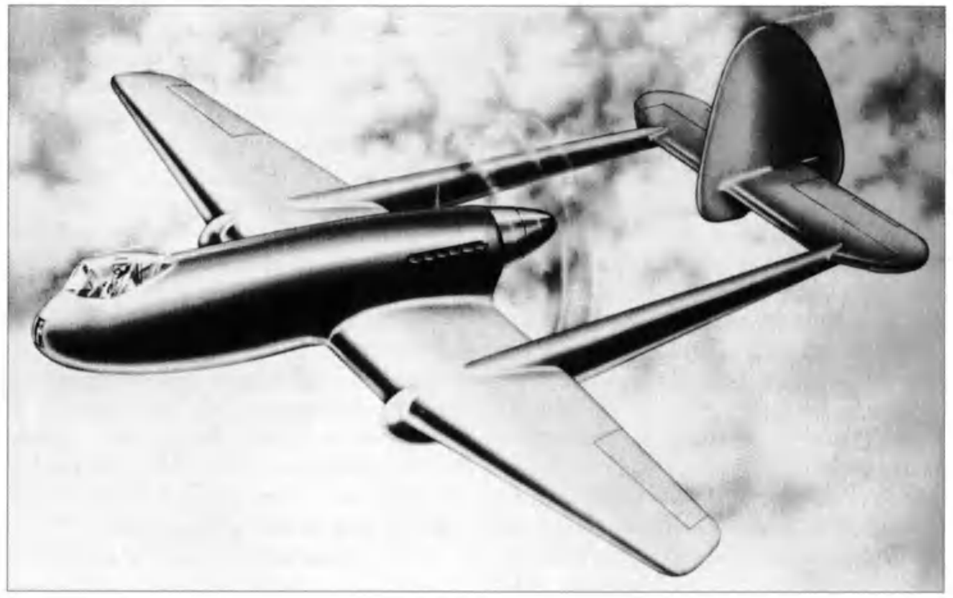
During the first years of the war the chief designer at AWA, John 'Jimmy' Lloyd, had become interested in low-drag aerofoils and in 1942 the company received a contract from the Directorate of Scientific Research to design and construct a full-scale wing section that would be used for laminar flow wind tunnel tests at the National Physical Laboratory. AWA's solution was to fit the wing's structure onto a relatively thick but accurately shaped outer skin, the reverse of usual contemporary practice where the skin was fitted to the structure, and the wing gave good results in the tunnel. By the time the ground attack requirement appeared, AWA had sufficient confidence in this wing to consider putting it onto a real aeroplane and the specification gave Lloyd the opportunity to do so.



Armstrong Whitworth AW.49 (11.9.42). Ray Williams



Boulton Paul P.99 (6.10.42). Les Whitehouse



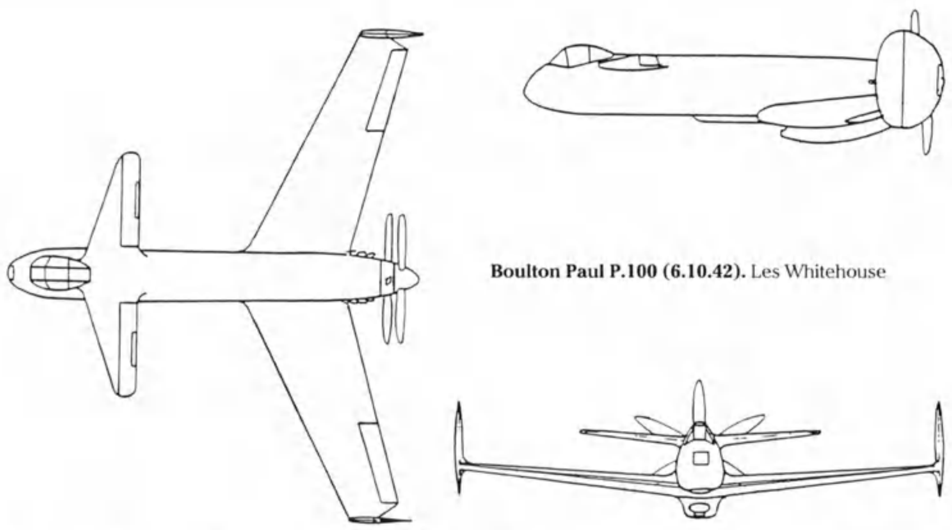
Artist's impression of the P.99. Les Whitehouse

The AW.49 was actually submitted two days before the invitation to tender was sent out. It had twin booms and a pusher engine, either a Rolls Merlin X or Napier Sabre IV, which helped the pilot's view and removed the turbulent airflow over the wing that would have been present on a tractor arrangement. A retractable or fixed undercarriage could be used although AWA recommended the former because a fixed version would cut the top speed by around 25mph (40km/h). Three 40mm cannon were housed in the nose and two 20mm in the wing roots, and the two 500lb (227kg) bombs would be carried under the wings; alternative weapon options were three 20mm and two 40mm, or five 20mm. Maximum range for the Sabre variant on internal fuel (175gal [796lit]) was 1,010 miles (1,625km). After the AW.49 was rejected, AWA continued its work on laminar flow and adopted the flying wing arrangement to get the maximum benefit from it. This resulted in the AW.52 research aeroplanes flown after the war and the AW.50 and AW.56 jet bomber projects.

Boulton Paul P.99

A similar layout to the AW.49 was adopted here but the P.99 used a Griffon engine and contra-rotating propellers and had a single fin and rudder in the centre of the horizontal tail; a tailwheel was also fitted under the fin. The major factors in choosing the twin booms were to give the pilot the best possible view while, at the same time, striving to meet the requirement that the aircraft should be capable of entering production in the minimum time (to satisfy this the aircraft would have to be ordered 'off the drawing board'). It was known that the American Lockheed P-38 Lightning fighter suffered from tail flutter at high speed which might produce some prejudice against the twin-boom configuration but a careful study of the causes of the P-38's problems, including a breakdown of flow resulting in the tail being in a turbulent region or rotational component of the slip stream, indicated that the P.99 should be free of them; the second item for example would not exist with contra-rotating propellers.

A normal tailwheel undercarriage was chosen since it would be more suitable for operating from advanced bases. Two bombs or eight RP were carried under the wings and there were alternative cannon fittings in the lower front fuselage, a single 47mm flanked by two 20mm or the twin 20mm in the middle with one 40mm to either side. A total of 260gal



Boulton Paul P.100 (6.10.42). Les Whitehouse

(1,182lit) of internal fuel was carried. To escape the propeller when baling out from the aircraft, the pilot had a downward escape mechanism in which the lower forward fuselage beneath his seat fell away. Maximum rate of climb (up to 2,000ft [610m]) was 2,140ft/min (652m/min) and range with normal load 785 miles (1,263km). The time allowed for preparing this project prevented its general construction from being determined satisfactorily (the issue was 'too important to be lightly treated') but Boulton Paul noted that very promising results had been obtained on the use of plastics, both for structural members and detail parts, and this knowledge and technique would be pressed into use wherever possible.

Boulton Paul P.100

This project, another pusher design with contra-rotating propellers, also featured a canard foreplane and had the main wing, with tip fins and rudders, placed to the rear of the fuselage. Such a layout required a tricycle undercarriage and the gun options available to the P.99 were supplemented by the additional choice of four 20mm cannon. This unorthodox design was chosen as the logical solution to the problems set by the specification. The size and weight of the armament was such that it demanded primary consideration and so the fundamental problem was to arrange the guns and sights in the ideal positions for operation and maintenance; the structural and aerodynamic arrangements were of secondary importance.

The P.100's layout solved the first problem 'adequately' while the second issue could be resolved by either 1) a twin-engined tractor aircraft or 2) a single-engined pusher with either a) twin booms, b) tail first or c) a pterodactyl arrangement. The twin tractor would be a more complex aircraft to manufacture and would not be so manoeuvrable as 2a or 2b, especially in the rolling plane, while 2c was a reasonable solution but its control and stability in the pitching plane was inferior to all of the others. The twin boom was aerodynamically conventional but was not as clean or light in weight as the tail first. In the tail-first machine both the stabiliser and main wings were lifting surfaces and it followed that for equal wing loadings the span of this aircraft would be smaller than for any other monoplane type. Consequently its rolling acceleration and velocity would be greater while pitching stability would differ little from the conventional machine, since both the longitudinal disposition of the main and stabilising surfaces were not much different.

The greatest departure from a normal aircraft was in the yawing plane and in order to harmonise the three controls it was felt that some special design features would be necessary. For both stability and control it was desirable to place the fin and rudder surfaces as far aft as possible and, to achieve this without tail booms, the wings had been given considerable sweep-back. In the absence of wind tunnel tests, calculations had been made which indicated that two quite moderate fin surfaces would give the required feet-off stability. In order to ensure that the stabiliser would stall before the main wing it was given a slightly heavier wing loading, which would eliminate the sudden dropping of a main wing if flying speed became too low. No tail also meant that there would be no tail buffet or flutter – the forward stabiliser would operate in undisturbed air and by placing it above the main wing the latter should also be clear of the stabiliser wake.

This configuration resulted in a saving in weight and drag against the rear fuselage, normal tailplane and elevator of a conventional layout and resulted in a considerable increase in top speed, roughly 9mph (14.5km/h). The pilot used the same system as the P.99 to depart the aircraft while the bombs and rockets were carried under the middle of the main wing; internal fuel capacity was also the same as the P.99 as were the comments relating to construction. Maximum rate of climb (up to 2,000ft [610m]) was 2,020ft/min (616m/min) and range with normal load 795 miles (1,279km). Contra-rotating propellers were more efficient than a single airscrew, especially in climb and take-off.

Boulton Paul P.101

Unusually for 1942 this project was a biplane but the basis for the proposal was the early 'in-service' date, Boulton Paul stating that 'nothing short of a stereotype design can hope to be in production by 1st January 1944'. Therefore the P.101 contained no unknown quantities, either aerodynamic or constructional, and could be 'ordered off the drawing board' with confidence. It lacked the excellent pilot's view of the previous designs but efforts had been made to fulfil all of the other requirements. The fixed undercarriage saved considerable weight but increased drag, although the requisite top speed could be achieved, and the aircraft's construction would adhere to standard Defiant fighter practice.

Two complete Defiant wings were used which were staggered to give a better view for the pilot while the guns were housed, along with the main wheels, in large spats. The options were four 20mm, three 40mm, two 20mm and two 40mm or two 20mm plus bombs or RPs; there was no provision for the 47mm but the required two 500lb (227kg) bombs were carried under the wing centre section and eight RPs were loaded under the outer wings. Maximum rate of climb (up to 3,000ft [914m]) was 2,200ft/min (671m/min) and range with normal load 750 miles (1,207km).

Cunliffe-Owen Attack Aircraft

This brochure actually described two aircraft, one single-engined and the other an orthodox twin-powerplant machine. No drawings have been traced for any of Cunliffe's ground attack designs but the twin was described as 'Mosquito-ish in general character' and carried 460gal (2,092lit) of internal fuel. Cunliffe considered the twin to be the really practical answer to the problem, in spite of objections to its size and the attendant reduced manoeuvrability. The small single-engine tractor, only 42ft (12.8m) in span, was more unconventional and, to improve his view, accommodated the pilot below the fuselage.

Phillips & Powis (Miles) M.42

This used the Libellula arrangement employed on several of the company's wartime project designs, which here meant a large straight canard foreplane with a swept mainplane fitted to the rear fuselage. The M.42 had two Merlin 30 engines mounted in nacelles on the main wing, yet it was only slightly larger than a Hurricane but had double the weight and power. Small size was a characteristic of the Libellula layout and contributed much to the high manoeuvrability of these designs. There were five alternative armaments (besides the two 500lb [227kg] bombs) mounted in the lower fuselage – three 40mm, two 40mm and two 20mm, four 20mm, two 20mm and six RP packs or one 47mm and two 20mm. Normal range for each of George Miles' attack designs was 750 miles (1,207km) but this could be doubled by carrying jettisonable tanks.

Phillips & Powis M.43

The Libellula layout was used again on the M.43, in fact this design was similar to the M.42 but was a little smaller and used a single and more powerful Griffon mounted in the rear fuselage; the main wing was also swept at a greater angle. Both designs had tip fins on the main wings and here, again, the guns were mounted in the lower fuselage. Both M.42 and M.43 were submitted on 7th September, ahead of the official invite to tender.

Phillips & Powis M.44

Despite offering potential advantages for a low-level attack aircraft, the Libellula arrangement was as yet unproven and would take longer to develop than an orthodox type. Therefore on 19th September George Miles submitted an additional conventional twin-engined design which had two Merlin 30s in underslung wing nacelles and twin fins and rudders. (Illustrations for the M.42, M.43 and M.44 can be found in *Miles Aircraft since 1925* by Don L Brown.)

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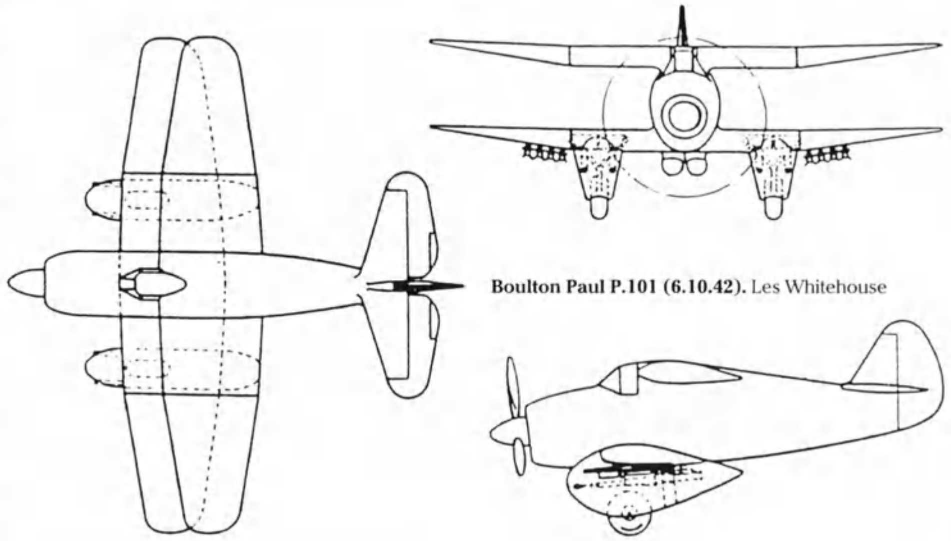
The man who did much of the analysis and appraisal of new aircraft designs was R N Liptrot and he completed his report on these ground attack types on 19th December 1942. He sounded disappointed that AWA had apparently not explored possible alternative layouts, but rather to have accepted from the very start that the twin-boom pusher was the most appropriate to a single-engined type to satisfy the requirements. Having accepted that, AWA had gone into the design far more thoroughly than any of the others. Quite apart from its laminar flow performance, the method of wing construction showed definite merit for a low attack aeroplane because it offered the desired simplicity and rapidity of construction. The AW.49 also carried more armament than the specification demanded.

Liptrot's biggest criticism was the AW.49's twin-boom arrangement was structurally difficult in regard to stiffness and that problems were anticipated in providing ground cooling for the engine – talks with Rolls-Royce confirmed that the pusher arrangement was quite impracticable unless fan cooling was provided. He also felt that Lloyd had considerably underestimated the structure weight and had made a big mistake in choosing the Merlin X – the Merlin 32 would be better and could replace it.

In his analysis Liptrot ignored the Boulton Paul P.101 biplane because of its relatively poor view and performance, and also the bad position of the armament where firing the guns would impose a heavy nose-down pitching moment. The twin-boom P.99 was closely comparable to the AW.49 but, through its use of the Griffon, it was considerably bigger. In addition the nacelle had 25% higher drag than the AW.49, the reason for which was unclear but this aircraft carried its fuel in the body whereas on the AWA it was in the wings. As a result the bigger engine did not 'pay for itself' from the performance point of view and the choice was not nearly so happy as the Merlin 32 would have been.

Boulton Paul's designer, J D North, had stressed the pilot's emergency exit arrangements strongly but Liptrot considered it an unwarranted piece of elaborate design which might easily prejudice the whole aeroplane. Once again the problem of pusher engine cooling on the ground was a factor but, in addition, the P.99's weight was underestimated by about 1,000lb (454kg), the performance estimates were considered 'optimistic' and there was 'no justification for the bigger aircraft made necessary by the Griffon engine'. For the tail-first P.100, the only criticisms were again the Griffon engine and that the weight and performance estimates were optimistic. However, other things being equal, the tail-first type should be some 500lb (227kg) lighter and 16mph (26km/h) faster than the design using a twin boom.

The Phillips & Powis brochures gave a totally inadequate description of the three possible layouts and there was insufficient information for Liptrot to make any valid criticism of the weight and performance estimates. He did, however, note that the general size and weight of these aeroplanes were 'ridiculously low in relation to the specific requirements'. On the other hand Cunliffe-Owen had 'entered into the spirit of our enquiries and has made a very complete and useful design study'. In the course of these studies the company had investigated single-engine types (both tractor and pusher), the twin-boom arrangement, tail-first types, shaft-driven tractors and more unorthodox arrangements. For one reason or another – engine cooling in pushers or long development times due to structural or aerodynamic problems (and so contrary to the necessity of having the aircraft in production quickly) – all of these had been abandoned and Cunliffe had settled on the two designs proposed.



Boulton Paul P.101 (6.10.42). Les Whitehouse

Liptrot felt that Cunliffe-Owen's single-engined design could meet the requirements as well as any possible single-engined layout and, in spite of its unorthodoxy, it was simple and perfectly straightforward. It did not introduce any new aerodynamic or structural problems but there would undoubtedly have been much antagonism towards it and so it was not assessed in depth. The company's twin-engined aeroplane had in fact the same geometry as the B.4/42 Mosquito replacement (Chapter 5) but, partly due to the designer's lack of contact with modern power units and Service requirements, particularly with armour, his weight estimates were quite unacceptable. Nonetheless the layout's geometry was quite appropriate to Liptrot's estimate of the probable weight, except that the flaps would have to be improved to give the specified landing distance (850 yards [777m]). The design's performance estimates were closely confirmed and showed that the Cunliffe twin promised to give the best performance of any of the proposed designs.

In conclusion, Liptrot declared that if the Air Staff insisted on high performance, coupled with simplicity of design and construction and quick production, the answer was a twin-engine type closely comparable to the Mosquito. Although bigger than possible single-engined types, it did not involve any of the difficulties attendant with the unorthodoxy that was inevitable with any appropriate single-engine machine. Its one demerit would be less manoeuvrability in the rolling plane though the Mosquito had shown that a twin-engined type of the size involved could be very manoeuvrable at low altitudes.

The ideal layout for the low attack type would possibly be the tailless pusher with a leading tail [canard] added to give the necessary handling qualities. Such a type would be smaller, more compact and, therefore, more manoeuvrable than any other possible layout, but there would be very considerable difficulties in developing the high lift necessary on the leading tail in regard to trim and correcting the poor directional qualities. This type was looked upon as exceedingly promising but also a relatively long-term development which in due course might give the answer to the problem, although not in an aircraft which could be in production in 1944.

A twin-boom pusher was the only single-engined type which could possibly meet the operational requirements and the need for rapid production, but it gave problems with structure and engine cooling. Liptrot recommended that, of the single-engined designs submitted, the AW.49 promised to be the best, subject to an adequate solution to the engine ground cooling problem. However, in spite of its size, the twin-engined aircraft was the safest choice and if the B.4/42 was to go ahead, they could quite easily derive a low attack version from it. Alternatively the Cunliffe-Owen twin could be adjusted to meet the requirements and would promise a better performance than any of the single-engined types that had been offered.

Martin Baker 'Tankbuster'

Several months later James Martin submitted his 'Tankbuster' design. This featured twin booms, a single rear-mounted Griffon II and one six pounder (2.7kg) anti-tank gun in the nose which was set on the horizontal axis of the CofG to ensure that the aircraft would not pitch when firing. Both radiator and oil tank, installed in the fuselage in front of the engine, were protected by offset armour-plated ducts to prevent bullets from being deflected inside the duct. The entire all-metal fuselage, and the engine cowling, was covered in ½in (12.7mm) thick armour which weighed approximately 4,900lb (2,223kg). The wings and tail were all-metal and a fixed tricycle undercarriage was used; maximum rate of climb would be 2,250ft/min (686m/min).

Martin-Baker's project was not attractive to the Air Staff because it carried only one big gun out of several weapons needed for low attack work, which meant it was only useable against one out of five or six types of target. It followed that to design a low attack aircraft around just this one weapon would be very uneconomical. It would probably be able to take other guns, bombs or rockets on the wings but they would make it very overloaded because it would be impossible to remove the big gun from the nose. The Air Staff considered it to be too specialised and on 15th April 1943 Air Marshal F J Linnell, a good friend of Martin, advised him to 'get ahead with your fighter [Chapter 1] with the maximum possible drive and not be led away by thoughts of Griffon editions or six pounder gun aircraft.'

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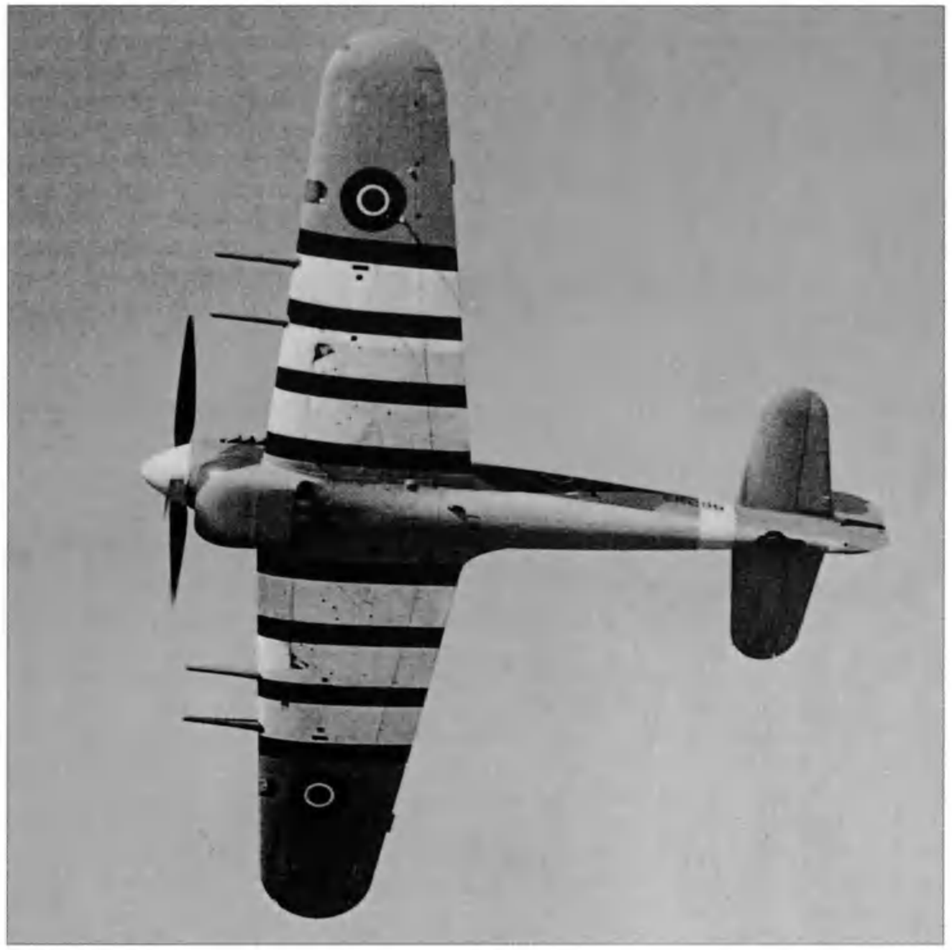
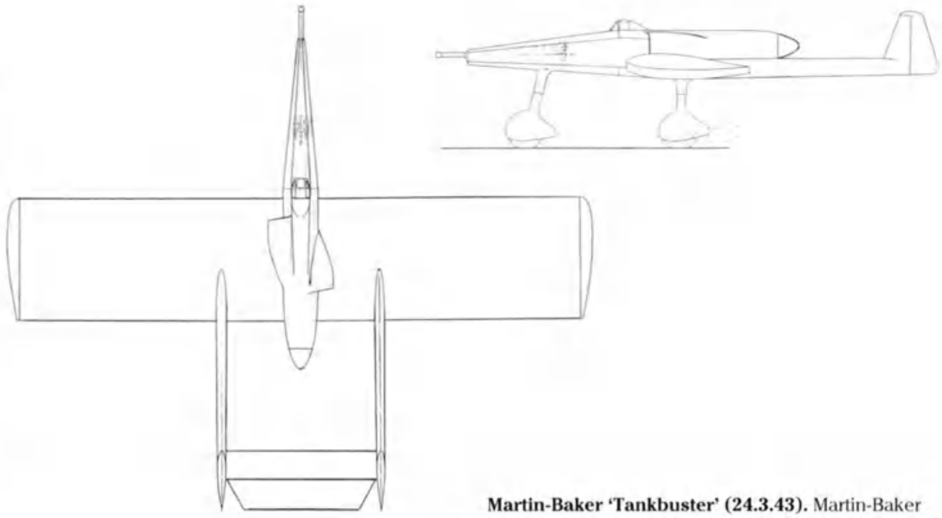
Towards the end of April 1943, after assessing all of these designs, the Air Staff concluded that 'there is insufficient to be gained at present by embarking upon a new and specialised type of low attack aircraft. For the immediate future, the Hurricane IV will meet our needs'. (The IV was another dedicated ground attack Hurricane which flew in March 1943.) The idea of a new design was given up for the alternative of modifying existing types and there was in hand a trial installation of two 40mm guns fitted on the de Havilland Mosquito (Chapter 5) plus a conversion for that aircraft to take the six pounder and carry rocket projectiles; there were also proposed developments of the North American Mustang. In due course the role was also admirably filled by ground attack versions of the Hawker Typhoon and Tempest carrying various weapons including rocket projectiles. These could be bolted onto the wing, had no recoil (which meant that they could be carried on anything) and on types like the Tempest they ensured that, once fired, the aircraft could revert to its fighter role. Today the concept of the ground attack aircraft is well established.



The Hawker Typhoon, with its four 20mm cannon, proved to be the RAF's ideal ground attack aircraft.



Martin-Baker 'Tankbuster' (24.3.43). Martin-Baker

Light Bombers and Ground Attack Aircraft – Estimated Data

Project	*Span ft in (m)*	*Length ft in (m)*	*Gross Wing Area ft² (m²)*	*Max Weight lb (kg)*	*Engine hp (kW)*	*Max Speed / Height mph (km/h) / ft (m)*	*Armament*
Light Bombers							
Fairey Battle (flown)	54 0 (16.5)	52 2 (15.9)	422 (39.2)	10,792 (4,895)	1 x Merlin I 1,035 (772)	241 (388) at 13,000 (3,962)	2 x 0.303in (7.7mm) mg, 1,000lb (454kg) bombs
Hawker Henley (flown)	47 10 (14.6)	36 0 (11.0)	342 (31.8)	9,400 (4,264)	1 x Merlin 2 1,025 (764)	300 (483)	750lb (340kg) bombs
Specification B.20/40							
Boulton Paul P.95	44 0 (13.4)	35 6 (10.8)	?	12,440 (5,643)	1 x Hercules VI or Griffon	323 (520) or 316 (508) at 16,000 (4,876)	10 x 0.303in (7.7mm) mg, 2 x 20mm cannon, bombs
Fairey B.20/40	49 2 (15.0)	39 11 (12.2)	?	11,810 (5,357)	1 x Merlin RM.5.SM	265 (426) at 10,750 (3,277)	6 x 0.303in (7.7mm) mg, bombs
Hawker P.1006	47 10 (14.6)	36 4 (11.1)	?	?	1 x Merlin RM.5.SM	?	6 x 0.303in (7.7mm) mg, 4 x 250lb (113kg) bombs
Westland Light Bomber	53 0 (16.2)	?	400 (37.2)	13,500 (6,124)	1 x Centaurus 2,150 (1,603)	290 (467) at 5,000 (1,524)	2 x 20mm cannon, 4 x mg, bombs
Ground Attack Aircraft							
AWA AW.49	48 0 (14.6)	36 2 (11.0)	325 (30.2)	10,316 (4,679)	1 x Merlin X 1,280 (954)	291 (468) at 3,000 (914)	see text
AWA AW.49	48 0 (14.6)	36 2 (11.0)	325 (30.2)	12,129 (5,502)	1 x Sabre IV 2,500 (1,864)	355 (571) at 3,000 (914)	see text
Boulton Paul P.99	44 8 (13.6)	45 6 (13.9)	360 (33.5)	14,074 (6,384)	1 x Griffon II 1,760 (1,312)	315 (507) at 17,000 (5,182)	see text
Boulton Paul P.100	40 2 (12.2) 20 (6.1) canard	34 2 (10.4)	270 (25.1) 67 (6.2) canard	13,450 (6,101)	1 x Griffon II 1,760 (1,312)	335 (539) at 17,000 (5,182)	see text
Boulton Paul P.101	36 7 (11.2)	33 7 (10.2)	?	15,210 (6,899)	1 x Centaurus 12.SM	317 (510) at 18,000 (5,486)	see text
Cunliffe Owen 'twin'	62 0 (18.9)	?	530 (49.3)	16,263 (7,377)	2 x Merlin 32 1,645 (1,227)	315 (507) at 3,000 (914)	3 x 40mm plus alternatives
Phillips & Powis (Miles) M.42	42 6 (13.0) 27 6 (8.4) canard	29 4 (8.9)	393 (36.5)	14,300 (6,486)	2 x Merlin 30 1,600 (1,193)	?	see text
Phillips & Powis (Miles) M.43	37 0 (11.3) 23 6 (7.2) canard	26 2 (8.0)	300 (27.9)	11,400 (5,171)	1 x Griffon 2,000 (1,491)	?	see text
Phillips & Powis (Miles) M.44	48 0 (14.6)	37 8 (11.5)	425 (39.5)	14,700 (6,668)	2 x Merlin 30 1,600 (1,193)	?	?
Martin-Baker 'Tankbuster'	48 0 (14.6)	40 10 (12.5)	c471 (43.8)	12,000 (5,443)	1 x Griffon II 1,760 (1,312)	270 (434)	1 x 6lb (2.7kg) cannon

Chapter Five

Medium Bombers

This unidentified Mosquito bomber (possibly B Mk.XVI ML991) has the larger bomb bay doors to accommodate a 4,000lb (1,814kg) Cookie bomb.

This chapter brings another point where overlap occurs between classes of aircraft. The text should really include Specification P.13/36 for a medium bomber but the aircraft that resulted from it were the Avro Manchester and then the Avro Lancaster and Handley Page Halifax, and all of those belong in Chapter 6. This section also embraces some high-speed twin-engined light bombers which could just as easily have fitted in Chapter 4.

Specification B.9/38 Armstrong Whitworth Albemarle

In early 1938 the Air Ministry was expressing plenty of anxiety that, should war break out, the supply of light alloys for aircraft manufacture could be affected. In fact the supply position was considered to be so uncertain that the Air Ministry wanted an aircraft built of alternative materials just in case there was a breakdown in the production of heavy bombers. Thus it turned to Armstrong Whitworth, Bristol and de Havilland to provide designs for a composite aircraft type which would not use any materials that were already being employed for aircraft construction – in other words their aeroplanes would be built mainly from wood and steel tubes which would not encroach on the available light alloy capacity. As a consequence the majority of the fabrication could also be done in the woodworking industry while the metal portions were confined almost entirely to steel tube factories. Specification B.9/38 was prepared to cover the type and designs were forthcoming from AWA and Bristol, both of which were chosen for manufacture. The initially very small specified bomb load was soon increased.

Armstrong Whitworth AW.41

Between the two World Wars AWA had had limited experience of designing and constructing in wood, most of its work had been in steel, but the 'ban' on the use of normal aircraft materials meant AWA used both alternatives in its design. This twin-engined study was submitted in February 1938 and could carry a normal bomb load of 1,500lb (680kg) over a range of 1,500 miles (2,414km), which could be increased to 3,500lb (1,588kg) over 2,000 miles (3,218km) in the overload condition. Despite AWA being instructed not to use any experimental techniques, the AW.41 did feature a tricycle undercarriage, an item which had been much used in America and offered possibilities that impressed AWA's chief designer John Lloyd. The aircraft was designed on the divided component principle where parts could be sub-contracted to firms and labour with little or no experience in aircraft work. Initially it included Rolls-Royce Merlin engines but, because the Air Ministry intended it to be a 'wartime' aircraft, it had to have a 'shadow' engine and the chosen alternative was the Bristol Hercules X. An AW.41 Mock-Up Conference was held on 22nd June.

Bristol 155

Few details survive for Bristol's proposals but there were two versions of the design. The first had a conventional tail-down undercarriage, two Hercules engines, a span of 80ft (24.4m) and was expected to reach a top speed of 302mph (486km/h); the second featured a tricycle undercarriage and a span of 70ft (21.3m) and with the same powerplant offered a maximum 319mph (513km/h). The normal bomb load would be 1,000lb (454kg) carried over 1,500 miles (2,414km) but these figures could be increased to 4,000lb (1,814kg) and 2,000 miles (3,218km). A Mock-Up Conference to assess the project was held at Bristol on 15th June 1938.

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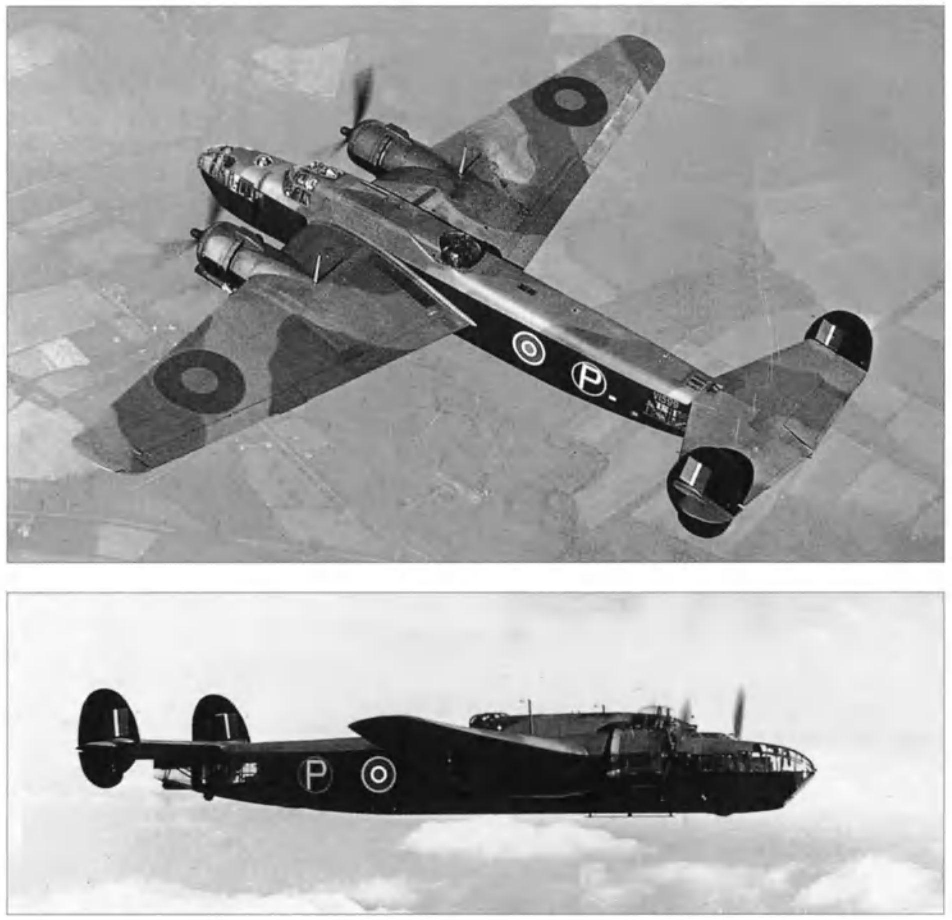
After the respective Mock-Up Conferences, B.9/38 was replaced by two new documents, B.17/38 and B.18/38, which covered the individual Bristol and AWA designs respectively. Both called for a minimum 250mph (402km/h) at 5,000ft (1,524m) at maximum economic cruising power and a maximum bomb load of 4,000lb (1,814kg). However, Bristol was busy with the Blenheim and Beaufort bombers and in late 1938 made a start on what was to become the Beaufighter, so work on its 155 composite bomber was discontinued. This move left AWA alone to work on its AW.41 which was a home-grown design and not, as so many published sources have stated, the Bristol 155 transferred to the company for completion.

However, by June 1938 changes in policy had revealed that the projected bomber fell short of the Air Staff's ideal for a machine of this type and it was therefore decided to proceed with the design on the lines of an aircraft primarily equipped for reconnaissance but with provision for bombing. This change meant that extra navigation equipment was needed together with more fuel to extend the range to 4,000 miles (6,436km). Hercules engines were selected as the power units and, after the necessary changes to the design had been made, a final Mock-Up Conference was held in September. Two defensive turrets were specified, one behind the wing spar to cover an attack from above and the second a retractable turret at the bottom of the rear fuselage to cover the downward field of fire. Instructions to Proceed with 200 aircraft, straight off the drawing board, were given on 15th October, well ahead of the type's first flight. It was emphasised, however, that the scheme was first and foremost an insurance and it was always realised that this form of construction would result in a 'second-best aircraft'. In fact the original intention had just been to fit engines to the first few airframes for trials and to keep the rest in storage without engines, for use only if the necessity arose.

The new aircraft was named Albemarle and the first prototype, P1360, made its maiden flight on 20th March 1940. However, it was found to require a very long take-off run and the span was subsequently increased, from the 9th production aircraft onwards, from 67ft (20.4m) to 77ft (23.5m). The new wing was first flown on the first production machine but there were other delays in getting the Albemarle into service and it was soon apparent that the type would not show much advantage over current types to make it acceptable for Bomber Command; it was clearly going to be outclassed by the new Stirling and Halifax (Chapter 6) and eventually all plans to use it as a bomber were dropped.

To establish the price that had been paid for its 'special form of construction', A&AEE's report on the Albemarle, completed in August 1941, compared the type to a Vickers Wellington Mk.III, an aeroplane with a similar bomb load and engines. The Wellington's tare weight (that is, no equipment fitted) was 20,600lb (9,344kg) while the Albemarle's minimum was 24,000lb (10,886kg), which was considered to be the cause of many of the aircraft's indifferent characteristics. The Wellington also exhibited a superior performance – 270mph (434km/h) at 14,300ft (4,359m) rather than the Albemarle's 264mph (425km/h) at 14,000ft (4,267m) – and had the ability to carry 4,300lb (1,950kg) of bombs, as against 3,850lb (1,746kg), over 1,500 miles (2,414km).

Nevertheless, in spite of these deficiencies, it was considered that the Albemarle offered a satisfactory performance and was capable of being used as a general reconnaissance aircraft. Eventually 602 were delivered, mostly to the RAF to serve as transports and glider tugs but others were despatched to the Soviet Union where they achieved some popularity as freighters; an attempt to convert the Albemarle into a torpedo bomber was a failure. In a review written on 17th April 1943, Lloyd declared that he had never shown very much interest in this composite design and it was clear that, had it not been for the Air Ministry's demand for a machine that could be built without impinging on the usual resources of the aircraft industry, AWA would never have considered building such a peculiar and experimental aeroplane. He added that 'the whole idea was for an aircraft that could be built by the tinker, tailor and candlestick maker outside the industry.'



These views of Armstrong Whitworth Albemarle V1599 were taken on 28th April 1944 when the aircraft was acting as a prototype for the ST Mk.1 'Special Transport' variant of the type. Ray Williams

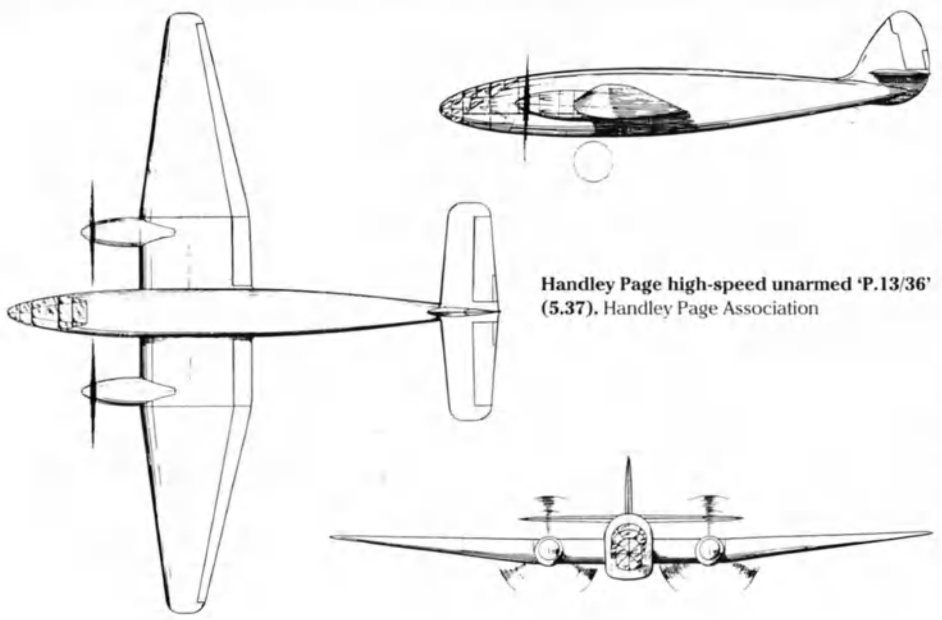
High-Speed Unarmed Bombers de Havilland Mosquito

The de Havilland Mosquito was to prove a highly successful aeroplane and become the RAF's first multi-role aircraft. Built mainly of wood and fitted with two Merlin engines, and no defensive armament to save weight, it was designed to fly so fast that no defensive fighters would be able to catch it. Many published sources state that the concept of the very fast unarmed bomber, as proposed by de Havilland in 1939 in a project which became the Mosquito, was a big surprise to the Air Staff and received vigorous opposition, except for the lone voice of Wilfrid Freeman. There was indeed much opposition to it, but far more support was forthcoming than has usually been recognised; in addition the concept of a fast unarmed bomber was not new because two years earlier Handley Page had put forward a similar proposal. In fact the idea interested some senior RAF officers as early as the late 1920s and in 1935 a possible twin-Merlin type was examined by RAE.

Handley Page Unarmed Bomber

In May 1937 George Volkert, chief designer at Handley Page, completed a twenty page document called 'A Memorandum on Bombing Policy and Its Influence on Design'. This was prepared, possibly in response to an approach from the Air Ministry's Research & Development department, with a view to assessing the 'benefits' to a bomber if it did not have to carry defensive armament and crew, a subject about which Volkert felt most strongly. He opened the report by declaring that a 'drastic revision of present ideas is essential if the utmost performance and destructive power is to be obtained'.

Part 1 assessed the current state of modern airborne warfare and bomber design. From a bombing point of view, one of several points noted that 'the need for providing complete defence from attack from every possible direction .... has [in this country] led to the almost universal adoption of nose and tail turrets, and a crew of at least four or five.' Volkert observed that 'the most efficient bomber is the one which can carry out the greatest destruction with the smallest crew and the simplest equipment' and added that 'every other consideration will have to be sacrificed to the need for high speed, without which the maximum element of surprise is lost in any attack, as well as the greatest safeguard of the crew. Just as the bomber depends for its success on sudden attack and surprise, so for its defence it must rely on high speed and high altitude together with poor visibility.' He also felt that the fast unarmed bomber could 'closely approach the aerodynamic ideal' whereas 'the fighter must in this respect remain inferior due to the presence of guns, sights and the like and the need for a wide field of vision for the pilot'.



Handley Page high-speed unarmed 'P.13/36' (5.37). Handley Page Association

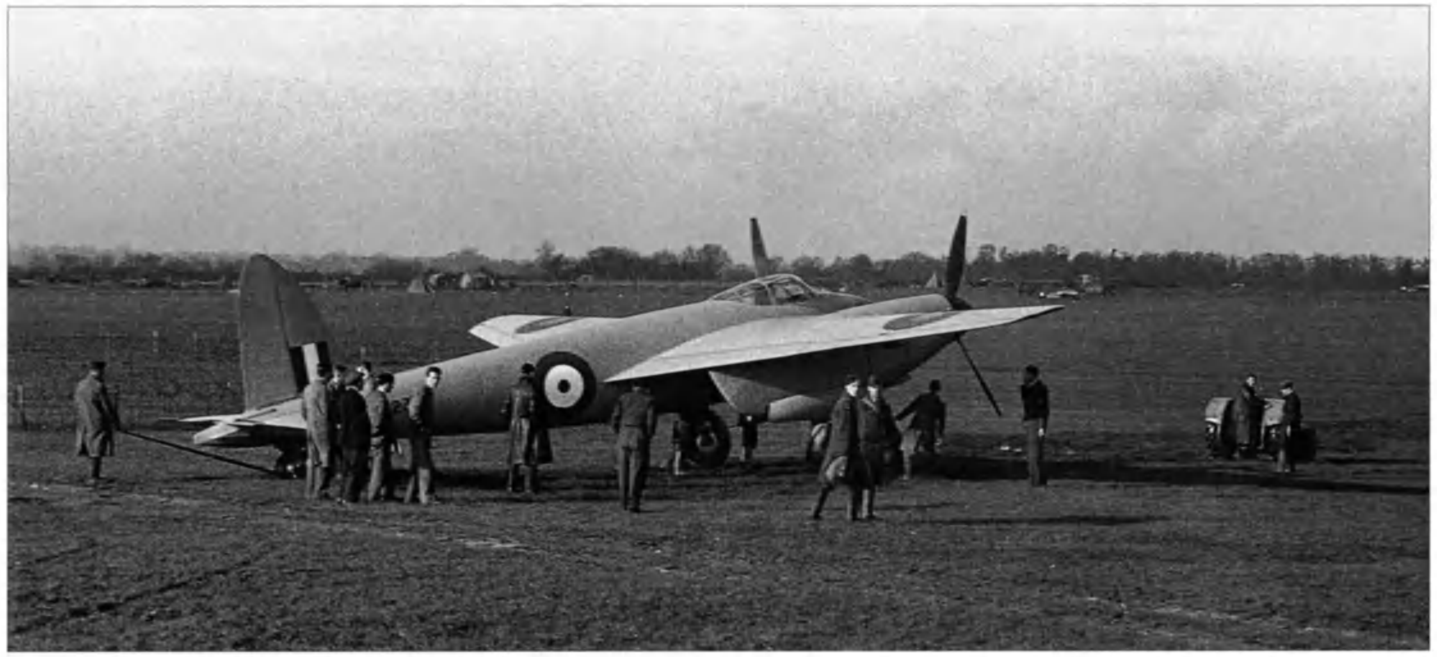
In Part 2 he presented an unarmed bomber project as a comparison to the existing P.13/36 medium bomber specification (Chapter 6). One point to be raised was that the armed bomber required many extra fully trained aircrew to risk their lives to defend their pilots and navigators while the aircraft itself would fly at least 22mph (35km/h) slower than the unarmed machine and, as a consequence, would have to spend more time in the air. Volkert's project possessed a near perfect aerodynamic fuselage with a 'pointed' nose and tail, a smooth exterior surface and a fully retracting undercarriage. The elimination of guns, gun crews and turrets greatly increased its bomb carrying capacity and made the aircraft much more manoeuvrable and safer to fly. It had a much simpler structure than the equivalent P.13/36 and the entire bomb load was housed in the fuselage leaving the wing for the fuel and undercarriage; this allowed the wing thickness at the centre to be reduced from 21% to 18%. The aircraft would be quicker, cheaper and easier to produce than the P.13/36 with defensive armament.

The unarmed machine when carrying a normal load of 3,000lb (1,361kg) of bombs, instead of P.13/36's normal 1,000lb (454kg), would be 1,165lb (528kg) lighter in all-up-weight (24,608lb [11,162kg] against 25,773lb [11,691kg]), it would cruise at 300mph (483km/h) instead of 278mph (447km/h), take-off and landing runs were shorter and the time taken to cover 1,000 miles (1,609km) was cut by 7.5%. The figures for higher bomb loads were equally impressive.

On 15th July Captain Liptrot, then Research Director Aircraft 3 (RDA3), completed an appraisal and his calculations suggested that this bomber's top speed could eventually exceed that of the Spitfire, the fastest fighter of the day, which would make it quite immune from attack by any single-seat fighter. His and Volkert's arguments gave strong support to the view that 'the elimination of defensive armament ought to be given serious consideration'. Liptrot acknowledged the counter argument that in the ups and downs of aircraft development there would always be a stage when there was a fighter possessing higher performance than the bomber then in service. However, as he had been 'pointing out for years', the maximum possible separation at any stage of development could not be expected to be more than 15% in favour of the fighter, so when a bomber in service had a top speed of 350mph (563km/h), the very best fighter within sight could not be expected to have a top speed of more than 400mph 644km/h). Other factors affected the fighter, such as time on patrol and endurance, and Liptrot deliberately continued his report in a provocative vein to start an argument within the service – he knew that the design of the RAF's future fighter and bomber aircraft would be critical to the country's survival.

The arguments did indeed follow. On 26th July 1937 R H Verney, DTD, gave the concept guarded support. CinC Bomber Command, Air Chief Marshal E R Ludlow-Hewitt, also supported the idea and gave his approval on 23rd April 1938 but noted that 'the term "unarmed" is, I think, a misnomer. It is not an unarmed bomber that we require but a *speed* bomber'. In August 1937 W Sholto Douglas, ACAS, wrote to DCAS urging support for the development of a smaller type of bomber, but DDOR was against the concept. CAS agreed on 5th December 1938 that a specification should be written and prototypes built. However, on the previous 7th August the Operational Requirements department declared that it was 'unsafe to assume that any great increase in the speed of a bomber can be obtained by the partial elimination of its defensive armament' and that 'the "speed" bomber does not show over the 'standard' bomber any substantial economy in production, maintenance, operational effort, flying personnel or wastage in time of war.' It concluded that the 'speed' bomber did not enjoy a sufficient advantage over the 'standard' bomber, in any material respect, which could compensate for its limited operational role.

On 7th August 1939, close to the opening of war, Ludlow-Hewitt wrote that 'I am strongly of the opinion that the development of the fastest possible bomber, whatever its size, is a project which ought to be put in hand so that we should have available a prototype of this kind of bomber should the need arise'. He felt such a project should 'no longer be delayed and that it should now be given the highest possible priority'. A week later Sholto Douglas, as ACAS, declared that he did not like the idea of an unarmed bomber, however speedy, because he did not believe that it would remain speedy enough for very long. He did, however, think it would be a wise precaution to encourage DTD to go ahead with the production of a prototype of Blackburn's B.28, a new private venture high-speed bomber design (described later).



De Havilland Mosquito prototype E0234 is seen on the Hatfield runway (for the first time?) on 21st November 1940. Barry Guess, BAE Systems, Farnborough

These paragraphs illustrate clearly that there was far more support for the unarmed high-speed bomber, at an early stage, than has usually been acknowledged. However, Handley Page's project was never likely to be built; Volkert's 'memo' concentrated more on the principles and ideas rather than any detail design but his document, and Handley Page and its designers, played an important part in establishing this category of aircraft in the RAF inventory. By mid-1939 discussions had moved on to some proposals from de Havilland which eventually were to fulfil all of the Service's hopes for a 'speed' bomber.

De Havilland DH.98 Mosquito

As noted, and again contrary to many published sources, long before the outbreak of war the Air Ministry was well aware of the value of adopting wood for aircraft construction to save light alloys and forgings. However, one considers it unlikely that the Air Staff ever imagined that it would actually acquire an outstanding multi-role aeroplane that used hardly any light alloy components whatsoever.

Sir Geoffrey de Havilland (GdH) and his staff felt an unarmed wooden bomber would be smaller, lighter and much faster than the conventional Specification P.13/36 (Chapter 6), which called for a medium bomber with forward and rear defensive guns, but it would still be capable of taking an effective bomb load well into enemy territory. On 6th September 1939 his team completed preliminary estimates for an aircraft powered by a single 2,000hp (1,491kW) Napier Sabre which had a span of 47ft (14.3m) and wing area 330ft^2 (30.7m^2) and which could carry 1,000lb (454kg) of bombs over 1,500 miles (2,414km) and reach 400mph (644km/h) at 16,000ft (4,877m).

Between 14th and 18th September comparisons were made between this and another design with two Merlins, a 55ft 6in (16.9m) span, 440ft^2 (40.9m^2) wing area and 400mph (644km/h) top speed. The latter was then scaled up into two further designs and all three were compared against a layout with a single Sabre or two Napier Enlarged Dagger (E.112) engines. By 4th October work had progressed to an aircraft of 51ft 3in (15.6m) span and 410ft^2 (38.1m^2) wing area with either two Merlins or two Griffons, the Merlin being the more favoured since the use of Griffons depended on the availability of that engine.

A letter to Sir Wilfrid Freeman, AMDP, on 20th September brought the first concrete proposals. Freeman was a supporter and GdH wrote 'we believe that we could produce a twin-engine bomber which would have a performance so outstanding that little defensive equipment would be needed'. He stressed that wood was specially suited to

Mosquito B Mk.IV DZ513.

really high speeds because all of the surfaces were smooth and free from rivets, overlapped plates and undulations, while its use would not encroach on the labour and material (described as 'bottleneck' material) being used in the RAF's expansion programme.

The preliminary specification was two Merlins, 1,500 miles (2,414km) range, two 500lb (227kg) or six 250lb (113kg) bombs, a pilot and observer and a maximum speed of 405mph (652km/h) at 20,000ft (6,096m). If Sabres were available the same performance and range was possible with 4,000lb (1,814kg) of bombs, three crew and two guns. Freeman consulted R N Liptrot who felt the firm was optimistic in suggesting such a high maximum speed. Later Liptrot expressed annoyance saying it was 'ludicrous for a firm making such a far-reaching claim for a new aircraft type to present it in so meagre a way'. He felt DH's weight predictions were far too low and that the speed was much too high and he predicted a maximum of 350mph (563km/h) and 19,500lb weight (8,845kg), which forced DH to revise its figures to 386mph (621km/h) at 20,000ft (6,096m).

On 1st November AVMs Arthur Tedder and Sholto Douglas, DGRD and ACAS respectively, agreed that this type would only be of interest as a bomber if it had effective rear defence, despite being aware that this would bring a drop in performance, 'but the speed of opposing fighters ... is such that we cannot hope to depend upon obtaining security by a margin of superior performance. If designed without effective rear defence, it could only be considered as a development aircraft for possible use on fast reconnaissance duties'. It was made clear to GdH that fitting this aircraft into future production plans was difficult, the supply of turrets would 'tax our resources' while producing the required additional engines was unlikely to be possible. They had 'regretfully' concluded that it would not be practicable to proceed with this type for production as a bomber but if the company was willing to consider it as a machine to help develop high-performance in-service aircraft, they were glad to consider it further. It was generally felt that if a successful prototype bomber was produced, it would be impracticable to fit it into the production programme without displacing other types and causing general dislocation.

In fact on 16th October DH had begun to study what effects fitting a defensive armament of two guns on top and one underneath might have. This resulted in a streamlined and fairly simple two-gun tail turret on the Merlin version but the arrangement knocked 20mph to 30mph (32km/h to 48km/h) off the top speed, so on the Griffon aircraft GdH decided to make the rear defence first class with a full four-gun turret. The more powerful engines ensured that the high speed was retained but calculations suggested the turret added 2,400lb (1,089kg) in weight to give a maximum of 18,000lb (8,165kg) and also made the aircraft more complicated to build. On 2nd November the initial studies were made towards a four cannon fighter version. H Grinsted, DDRD, noted that 'our experience of Messrs de Havilland is that they are extremely slow in producing anything for the RAF' and added that most technical and production experts had grave doubts as to the company's ability to achieve its performance and production promises.

On 8th November Grinsted heard from C C Walker, DH's chief engineer, that the Griffon aircraft's size had been increased but, fitted with a Frazer-Nash four-gun tail turret, capacity for 1,000lb (454kg) bombs and a crew of three, it could still make 390mph to 400mph (628km/h to 644km/h) at 20,000ft (6,096m). Walker stressed how quickly this aircraft could enter production but acknowledged that the Air Ministry would not commit itself to large production on a type for which it had no experience. On the other hand, DH could not put all of its design effort towards producing a single prototype so the idea of a small batch of aeroplanes was suggested as a solution.

At a conference held at Whitehall on 12th November it was decided to arrange ordering around fifty examples of the DH.98, as the project was called, with Merlin RM.2.SMs. Tedder informed GdH on 20th November that it had been decided to build two prototypes with the four-gun turret and asked him to construct a mock-up. At this point there were actually three high-speed bomber projects now under discussion, the DH.98, the Blackburn B.28 and a bomber conversion of the Bristol Beaufighter (presumably the Type 157). The latter was not considered to be very promising but both Blackburn's and DH's designs did generally conform to the broad bomb load/range requirements that the Air Staff had in mind.

A meeting held at the Air Ministry on 22nd November, which included W S Farren, Wilfrid Freeman and Liptrot plus Clarkson and Bishop of de Havilland, brought matters together. The two versions of the DH.98 were of similar size but the second had a rear turret that produced a difference of 30mph to 40mph (48km/h to 64km/h) in speed. Bishop reported that the first design would demonstrate the main features of the type whereas the second was a development adapted as a bomber for service use, but the main objective was to produce an aeroplane within about nine months without interfering with the production of other types; it was not the company's intention to produce both aircraft simultaneously. DH claimed that the design was four years ahead of the Spitfire, its wood construction was so perfected that the smooth skin would eliminate sources of drag and its ducted internal radiators added 10mph (16km/h) to the speed.

Freeman contended that introducing a turret tended to defeat DH's objective of producing a bomber which would outpace the contemporary fighter. The question was speed versus armament and Freeman suggested that DH should concentrate on an aeroplane which could not be overtaken by any contemporary enemy aircraft. If the following programme could be guaranteed by the company, he would recommend it to the Air Council purely as a gamble:

a. Provide a Merlin aeroplane having the highest possible speed with a maximum 1,500 miles (2,414km) range within the next nine months;
b. Then immediately commence constructing a modified type with Griffons capable of the same range at 375mph (603km/h) and to be ready within another nine months;
c. Then commence a still further modified type with Sabre engines capable of greater speed over the same range.

Freeman got his way in having any guns deleted and a draft requirement was raised for a high-speed light reconnaissance aircraft capable of 400mph (644km/h) at 18,000ft (5,486m). An order for fifty was placed on 25th January 1940 and Specification B.1/40 was completed around DH's proposals on 1st March. Within the Ministry, however, there was still some fierce opposition. Surprisingly Ludlow-Hewitt, considering his comments towards the Handley Page project above, insisted on the absolute necessity of rear defence. His objections were mainly based on the grounds of tactics. He wanted his fast bombers to penetrate individually heavily defended territory to reach selected targets and, for reasons of morale if nothing else, it was necessary for the aircraft to be able to defend itself. One convert, however, was AVM Tedder and, in addition, the broad idea that de Havilland should design and build an aircraft of its own was felt to be a good one.

RG314 was a photo reconnaissance Mosquito PR Mk.34.

DH submitted its detailed estimates for both Merlin and Griffon machines at the end of November 1939 and, thereafter, intensive work proceeded on the unarmed Merlin type or a fighter version with an alternative four cannon nose until year's end, when the design requirement was finalised. A mock-up was examined at Hatfield on 29th December and such was the pace of the work that when the specification was raised in January 1940 de Havilland was almost ready to start construction. For a period it looked as if one of the prototypes would have leading edge ducted radiators and the other underslung Beaufighter style radiators, but the second arrangement was not actually flight tested until mid-1943 when it revealed a quite violent tendency to wing drop. It transpired that the Mosquito's leading edge entry produced an early stall and thus avoided any premature loss of lift at the tips.

GdH first proposed the alternative long-range fighter version in May 1940 and two months later further unease about the unarmed bomber helped the authorisation for another prototype to be built as a fighter. Liptrot quickly requested a specification, which became F.21/40, for an aircraft armed with four 20mm and four 0.303 (7.7mm) nose-mounted guns. However, much debate centred on whether this aeroplane should be primarily for day or night work and would it be armed with fixed guns or a turret? Experience of regular German air raids meant that night fighting tactics were being modified almost nightly while the new development of air interception radar was another factor. In the end a two-seat fixed-gun fighter was selected.

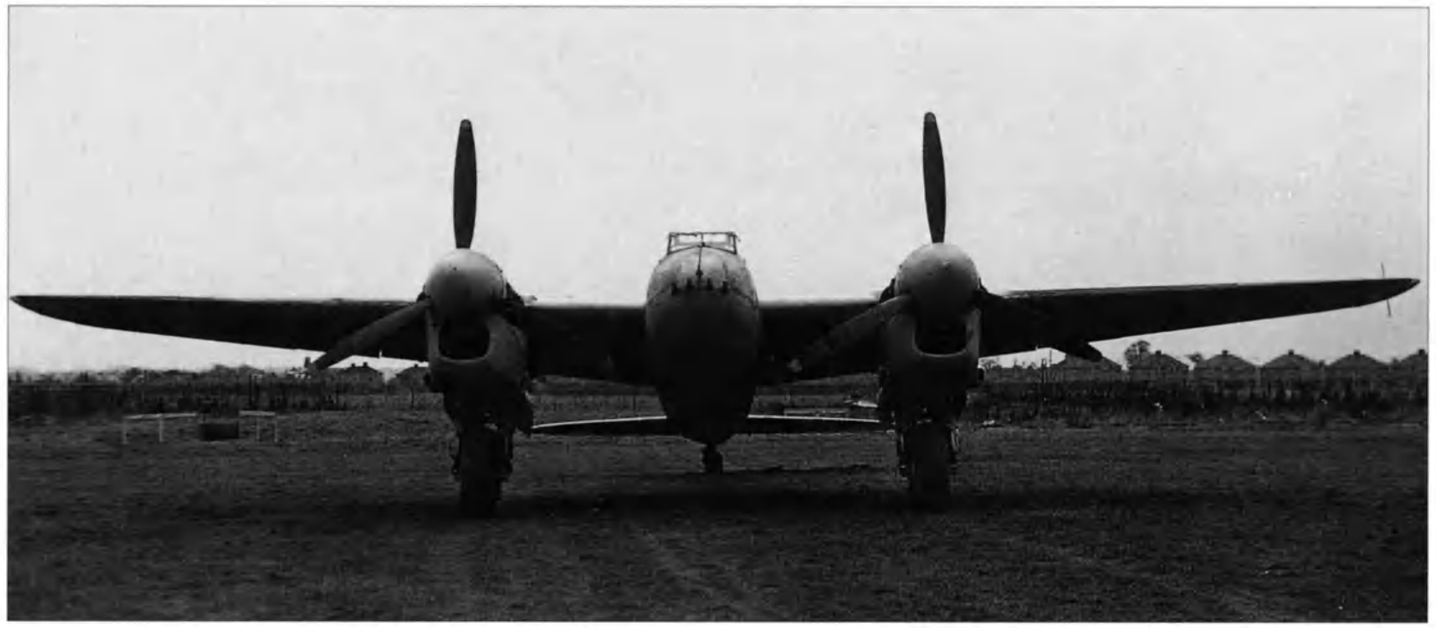
Another influence was the AS.48 night fighter from Airspeed, a project which was abandoned after its drawings, data and mock-up were destroyed during a bombing raid on Hatfield on 3rd October 1940. It was clear that a variant of the Mosquito long-range fighter could undertake the night fighting role and this version eventually received a go-ahead while the original long-range Mosquito was dropped. AVM Linnell wrote on 29th April 1941 'I am hopeful of great things of the Mosquito as a night fighter'; when this variant flew seventeen days later it did not sport the nose-wheel tricycle undercarriage which, at one stage, was thought to be needed.

The existence of the fighter variant certainly helped to keep the Mosquito alive because there was still plenty of criticism, even after the bomber prototype had flown in November 1940. On 2nd December 1940 'Archie' (Sir Archibald Sinclair, Secretary of State for Air) wrote to 'Max' (Lord Beaverbrook) saying 'War experience tends to show that this bomber would be useless for the purposes for which it was designed. On the other hand I am inclined to think that it may be useful for photo recce and target towing if the equipment can be installed'. He did feel that it might be possible to use it for short-range bombing in suitable weather conditions but suggested that no more orders should be placed until satisfactory prototype trials were complete. Two weeks later 'Archie' added that he did feel better about the Mosquito fighter.

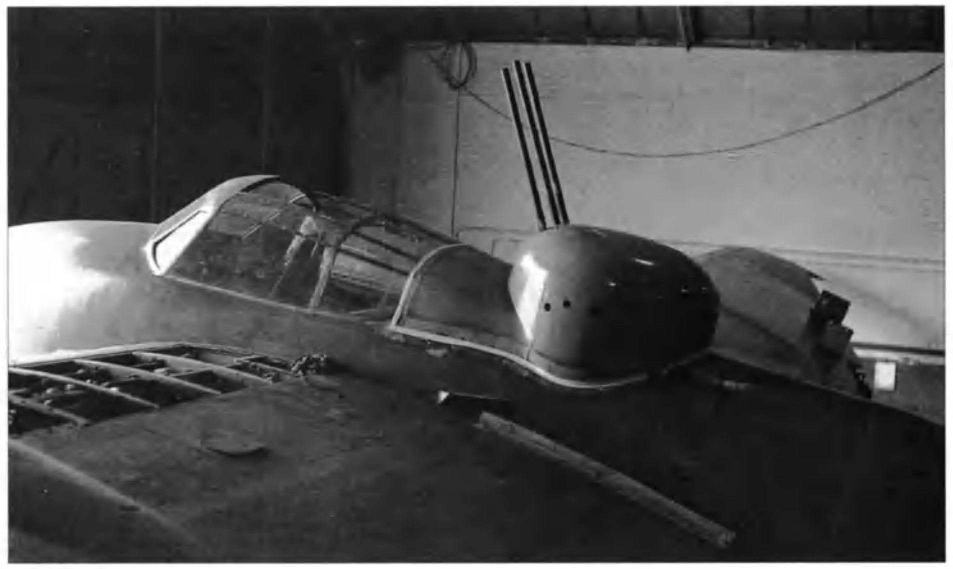
In early spring 1941 Sir Henry Tizard was asked to appraise all of the industry's new aircraft types currently in the design and development stage and to give views as to their future. His comments on the B.1/40 Mosquito were brief: 'This was originally a "stunt" machine to be developed in small quantities. It has flown satisfactorily but I do not think it will be particularly useful for anything. I understand only a small order has been placed and a few of them may fill a useful purpose – e.g. long distance ocean fighter'. Freeman, now VCAS, wrote a typically vitriolic observation to Air Marshal Linnell on 29th April which embraced the whole subject of forthcoming types but clearly had the Mosquito in mind: 'Tizard's experience is negligible. He believes in figures and promises, both as regards delivery and performance, which have no basis for justification, and I will not agree to a sacrifice of a really good certainty for the doubtful Whittle [that is, the Meteor jet fighter, Chapter 11] and the [Hawker] Typhoon/Tornado, which we know, without considerable alteration, will not be able to operate at great heights. I take it that this file will not go to Sir Henry Tizard'.

The first Mosquito flew on 25th November 1940 with Class B serial E0234 (the name Mosquito had been bestowed by June 1940). A visit to A&AEE Boscombe Down from 19th February 1941 for brief handling and performance trials revealed that the aeroplane was pleasant to fly with its flying qualities considered generally good. Best rate of climb was 2,880ft/min (878m/min) at 11,400ft (3,475m) and top speed 388mph (624km/h) at 22,000ft (6,706m). The last figure brought general astonishment. Nobody, not even the de Havilland team, were sure it that would be faster than the Spitfire and many officials had poured scorn on the idea, yet here it was – 388mph. De Havilland's Richard Clarkson remembered Fred Rowarth, Boscombe's chief technical officer, taking his hat off to the Mosquito's speed after he had completed the calculations (the average maximum speed of early production aircraft proved to be 383mph [616km/h]). From now on many more took the aircraft seriously. On 16th January 1941 E0234 was flown at 6,000ft (1,829m) alongside a Spitfire and the Mosquito was able to fly away in 'a fairly convincing manner'.

Chin radiators were tried on Mosquito Mk.II fighter DD723 but were rejected. This view was taken on 11th February 1944. Barry Guess, BAE Systems, Farnborough



The mock-up four-gun turret fitted behind the cockpit of Mosquito W4050 was photographed on 6th August 1941. As expected this modification caused a substantial loss of speed through extra drag, although the aircraft's handling was fine. Barry Guess, BAE Systems, Farnborough



There were still frequent design changes to be made due to the evolution of the fighter requirements and the failure of the Air Staff to decide i) whether it definitely did not require the unarmed bomber version and ii) what proportion of the total output was to be built as bombers, fighters or photo reconnaissance aircraft. The last pair always had precedence over the bomber but the bomber was never actually cancelled. As if in full and final acknowledgement to DH's thoughts on gun turrets, the suggestion to fit one in mid-1941 was rejected by the Ministry after some flight tests. N E Rowe, DTD, wrote on 4th July that the turret 'must be kept in front of the rear spar to preserve the balance of the aeroplane'. The original position (shown in the photograph) meant that it protruded into the middle of the bomb compartment which thus prevented any bombs from being carried. By moving the turret as far aft as possible towards the rear spar it was conceivable that two 250lb (113kg) bombs could be carried, but that position needed the fuel tanks to be redesigned while the CofG would then be at the limit for acceptable longitudinal stability.

Over and above these basic difficulties, however, flight testing showed that the turret resulted in a serious loss in speed and gave an increase in landing run. Rowe reported that at 22,000ft (6,706m) the optimum range speed dropped from 252mph to 220mph (405km/h to 354km/h) and maximum cruise from 335mph to 300mph (539km/h to 483km/h), while the maximum full throttle level flight speed at 23,000ft (7,010m) fell from 378mph to 340mph (608km/h to 547km/h). Rowe concluded that 'it is impractical to turn the Mosquito into a bomber with a four-gun turret and still retain a reasonable bomb load. Moreover, and bearing in mind that the top speed of the Spitfire V is only 385mph (619km/h) at 23,000ft (7,010m), it seems essential to retain the highest speed possible in the aeroplane'.

Eventually the Mosquito proved itself to be an outstanding aircraft in almost every role given to it, the list of which grew once its superb performance was acknowledged. As confirmation of the type's acceptance, on 24th July 1941 the Air Staff reported that it was 'very anxious to make the utmost use of the potentiality of the Mosquito' and it was pushing to increase production to 150 per month. A total of 7,781 was eventually built and production did not close until 1950. De Havilland also studied a development of the Mosquito with four Merlins as a 'fast' heavy bomber but the general arrangement drawing known to have been produced has not been found. In 1941 the company did put forward a design for a high-speed unarmed night bomber, which was a fairly big aircraft of around 46,000lb (20,866kg) weight, and it seems pretty certain that these were the same project.

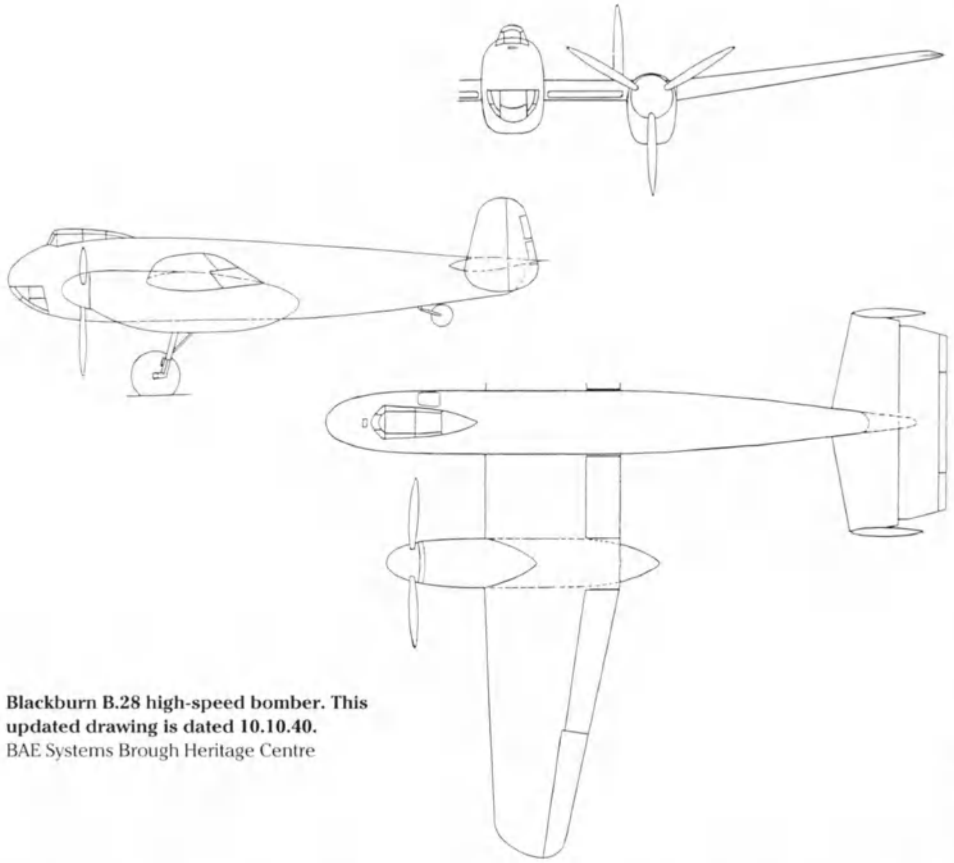
Specification B.3/40
Blackburn B.28

This private venture high-speed light bomber and reconnaissance design, first proposed in 1939 and mentioned briefly above, was based on the Botha torpedo bomber (Chapter 9). It was powered by two Griffons and had a span of 54ft 9in (16.7m) and length (tail down) of 39ft 0in (11.9m). Specification B.3/40 was written around the project and indicated a maximum speed of at least 400mph (644km/h) at 18,000ft (5,486m), with the warload to include two 500lb (227kg) or four 250lb (113kg) bombs; there was also an allowance to fit a four-gun turret. This seems to have been a quite long-lived project and one prototype, X8500, was ordered in 1940; a mock-up was also built but the B.28 was eventually abandoned.

High-Speed Bombers
Hawker P.1005

In late 1940 Hawker began scheming this project for a high-speed light bomber fitted with two Sabre IV engines. There was strong feeling that the RAF needed a new machine which could be either a high-speed bomber or a high-speed long-range fighter and it was felt that the production and maintenance benefits gained by using the same basic aircraft for the two types would be immense. Such a type offered less time over enemy territory, a high useful bomb load and less production hours than a heavy bomber but it would only be satisfactory if high speeds, in excess of 400mph (644km/h), were provided. Hawker felt that its experience in the techniques used in designing the Typhoon high-speed fighter (Chapter 1) could be most usefully employed here, rather than the techniques of heavy bomber design.

The P.1005 had three radiators situated either side of each engine inside the wing and in the chin position under the propeller, a fuel capacity of 1,100gal (5,000lit) and a main undercarriage hinged just inside the engine mountings which retracted sideways into the thick centre-wing section. Flaps were provided and the ailerons were fitted along the outer wings while the choice of twin fins and rudders meant that a full length elevator was available (an alternative single central fin had

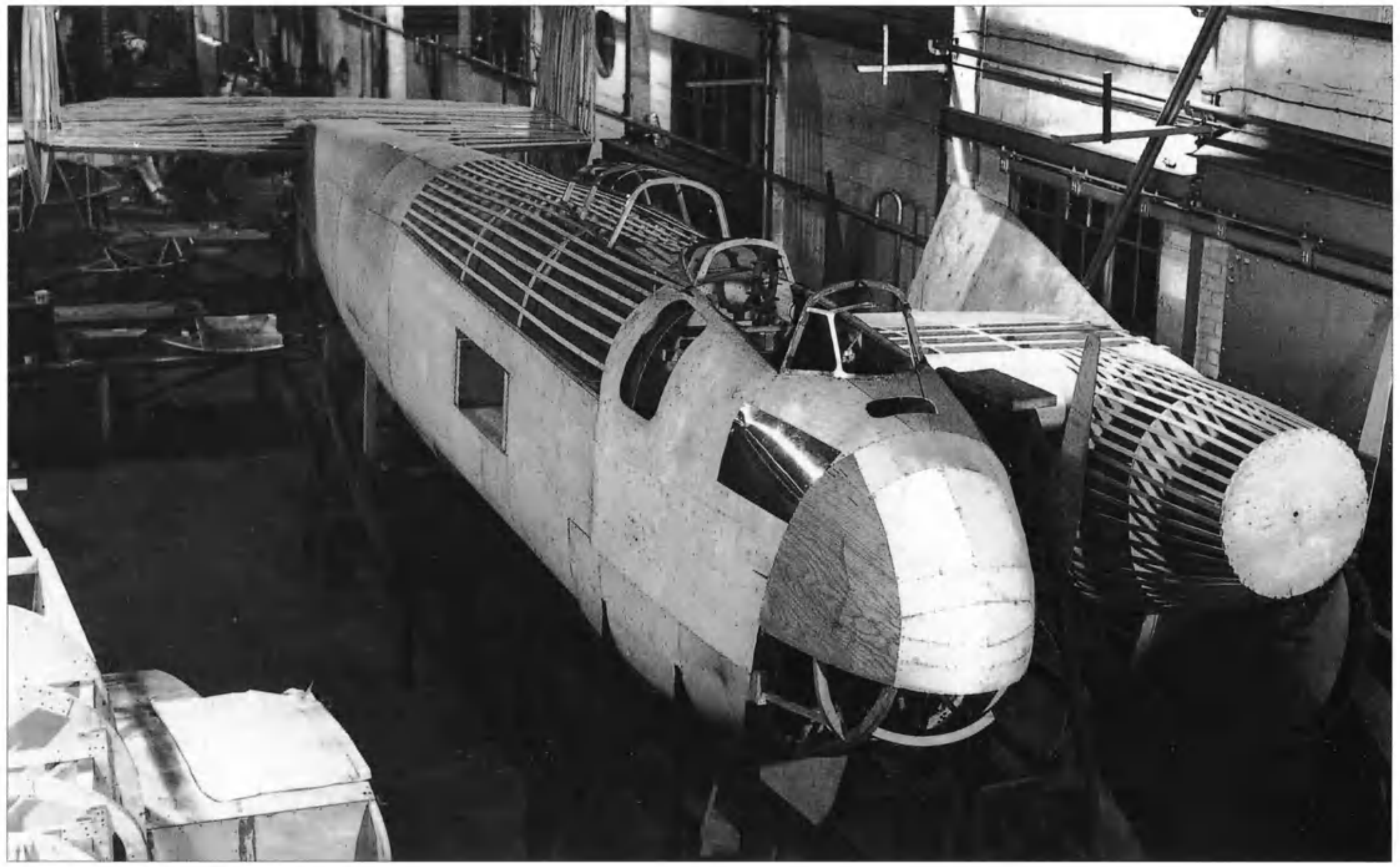


Blackburn B.28 high-speed bomber. This updated drawing is dated 10.10.40.
BAE Systems Brough Heritage Centre

been examined). Construction was all-metal and the aircraft had a comparatively narrow fuselage.

The original objective was a bomb load of 2,000lb (907kg) but, after the requirements were increased, the internal weapon bay was eventually capable of taking up to 4,000lb (1,814kg) in the form of four 1,000lb (454kg) bombs, two 2,000lb or a single full 4,000lb bomb. Like the Mosquito the P.1005 had no defensive armament but provision was made for a circular 41in (104cm) diameter retractable turret installation in the dorsal position which would house four 0.303in (7.7mm) machine guns. The turret and its guns were designed to sink down into the fuselage on retraction, leaving just a small protrusion (shown on the fighter drawing) to disturb the streamlining; the turret's gunner raised the crew to four. The high-speed fighter variant was initially just a simple conversion that saw the introduction of a pair of forward-firing 20mm cannon to complement the turret's machine guns. However a more drastic modification was eventually completed with a shorter fuselage nose and six 20mm cannon beneath the cockpit.

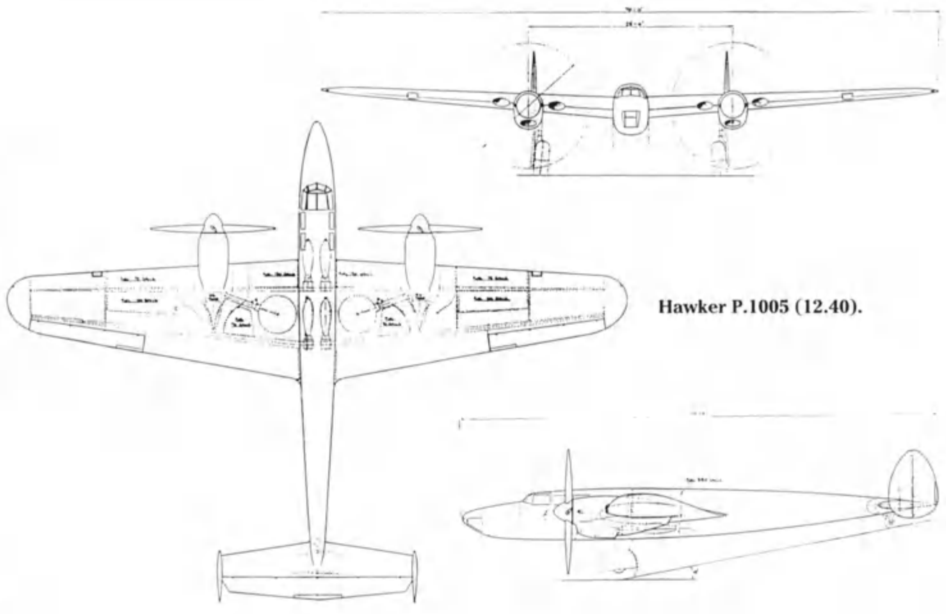
The B.28 mock-up pictured on 9.11.40.
BAE Systems Brough Heritage Centre



The P.1005 was submitted to the Ministry around the turn of the year and on 4th February 1941 Liptrot completed his appraisal in which he described the aircraft as a logical follow-on from the Mosquito. At this time a high-altitude version of the selected engine was under development which Liptrot stated would improve the climb and altitude performance. Operationally he gave the P.1005 merit over the Mosquito because it provided more normal equipment and a higher bomb load and did not attempt to rely solely on its speed and evasive power for safety, instead providing the four-gun turret for rear defence; the turret was also seen as an advantage over the Mosquito's fixed 0.303 (7.7mm) machine guns. Liptrot closed by saying the only major weakness was a slightly inadequate cruising range and he requested that Hawker should rectify this.

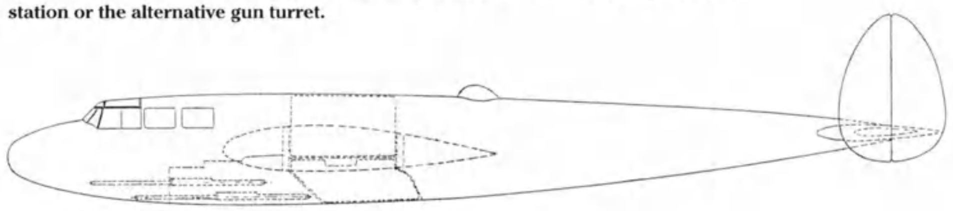
Rowe, however, expected an increase in weight as the design was developed and stated that only a product of the highest class was likely to be of value operationally. On 24th April he spoke to Sydney Camm and the designer chose not to push for a production order at once but instead settle for the aircraft solely as a prototype for the time being, with a review of the situation to follow in three to six months. He knew that the P.1005 would need two Typhoon engines and there would never be enough of these available, although perhaps in time a resource of engines would build up. Rowe reported this to Sir Henry Tizard who replied that they should push the aircraft forward saying 'we want to know what we can get from a really well designed twin-Sabred aircraft' – the P.1005 was felt to be the best proposal so far for a light bomber schemed around two Sabre engines.

In November 1941 draft Specification B.11/41 was written directly around the P.1005 and described a twin-engined high-performance bomber capable of being converted into a long-range fixed-gun fighter. As a bomber maximum speed was to be 400mph (644km/h) at 25,000ft (7,620m) (later increased to 430mph [692km/h]) and range with a 2,000lb (907kg) load 1,600 miles (2,575km) at 30,000ft (9,144m) (later raised to 1,750 miles [2,818km] with a 4,000lb [1,814kg] load); additional removable fuel tanks would be fitted for fighter operations to give a range of 2,100 miles (3,380km). B.11/41 was issued in early June 1942. The P.1005 brochure quoted a ceiling of 32,500ft (9,906m) and a time to 20,000ft (6,096m) of 10.5 minutes; with high-altitude versions of the Sabre fitted it was thought that a speed of 430mph (692km/h) would be possible at 36,500ft (11,125m).

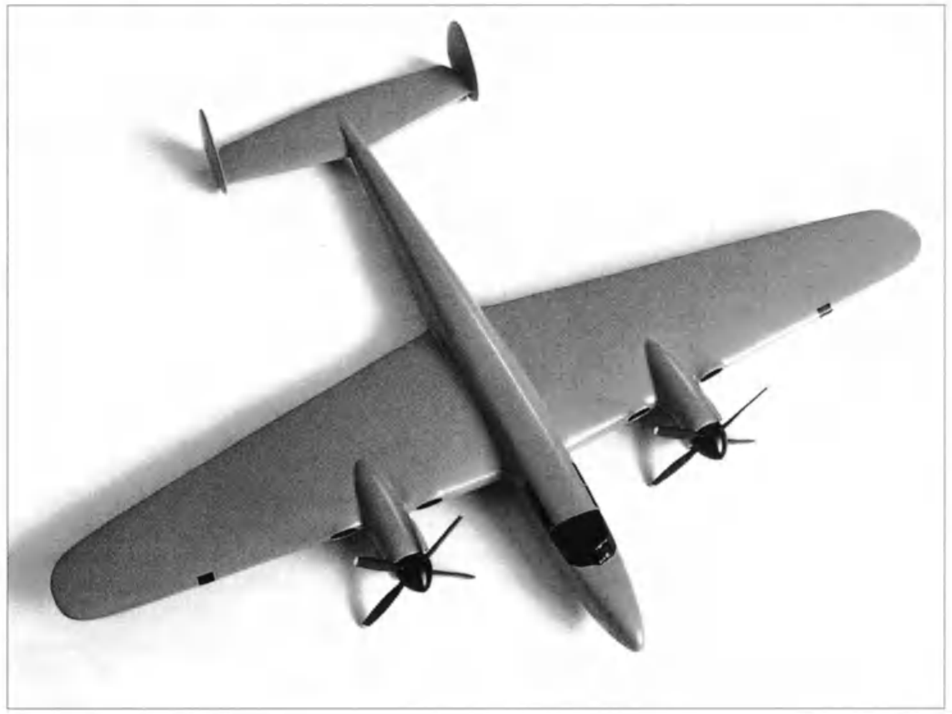


Hawker P.1005 (12.40).

The High-Speed Fighter version of the P.1005 with a shortened nose and six 20mm cannon. The small dorsal fairing indicates the position of the Wireless Operator's station or the alternative gun turret.



Below: **Model by Joe Cherrie of the Hawker P.1005.**



On 22nd October 1941 the Ministry declared that the P.1005 (also known as the Camm B.11/41) must come into production at the expense of the Hurricane and at a ratio of one Camm Bomber for two Hurricanes. However, this decision would be affected by the appearance of some competition in the shape of the Mosquito, whose value was at last receiving appreciation, and a new design from Bristol called the Type 163 Buckingham (below). In addition a Sabre-engined Mosquito development called the DH.101 was prepared during the autumn of 1941 (and is described shortly).

Back in early August Air Marshal R S Sorley, ACAS(T), had compared these aircraft for CRD, Air Marshal F J Linnell. The Hawker gained in bomb load and speed at the expense of range and defence and, to a degree, poor navigation facilities. Its excess of speed over either was not great, while its armament was distinctly inferior to the Buckingham. Thus it seemed to Sorley that the Hawker B.11/41 fell into the category of a Mosquito replacement and in this the development possibilities of the Mosquito had to be taken into account because the Hawker was over than a year further away from reaching production than the DH design. Sorley added that unless the B.11/41 had a development future that could be foreseen, it did not presently offer a sufficient advance to warrant large-scale production. He feared that the Air Staff would commit itself to the production of a design that in fact might already be at the end of its tether but then softened this comment by declaring that he had the greatest confidence in Sydney Camm, all of whose aircraft 'had astonishing developments in them'. He hoped that the P.1005 would show similarly good prospects.

On 18th November MAP requested 400 Bristol Buckinghams and 1,000 Camm bombers, but on 18th December the Aircraft Supply Council stated that development of the Buckingham, Hawker B.11/41 and an improved Mosquito might result in three types of fast day bomber being put into production, thereby repeating the state of affairs which had resulted in too many heavy bomber types (Chapter 6). Linnell added that he had doubts about attempting the improved Mosquito. However, on 9th December, MAP's Research and Development department had written to RAE stating that 'a production order is about to be placed for the high-speed fighter bomber which has been developed by Hawkers in a semi-private manner to date. A draft production specification has been drawn up to cover this order.'

On 22nd December a meeting was held between Rowe, DOR, Camm and other Hawker staff, plus some equipment installation and armament development representatives. Camm said that Hawker would now design the aeroplane to carry the 4,000lb (1,814kg) bomb load but it was agreed that no steps were to be taken that would embarrass the project's primary function, its high speed. On 1st January 1942 Sorley noted that the P.1005's planning should proceed rather carefully. The project had been 'on and off for quite six months and it is only within the last two months that a final decision was taken to have it produced'. He felt that another change of mind would have a very bad effect upon Hawker, and probably MAP, but if DH were to do a Mosquito replacement, 'then there is not a good case for having both' and cancellation of the P.1005 would allow a greater concentration upon the Typhoon fighter. Three days later Camm asked Rowe about the prospects for using the P.1005 as a fighter and was told that this was entirely secondary to the main bomber role. As a fighter the agreed armament was now four 20mm but Rowe wanted Hawker to concentrate on the design of the aeroplane as a day bomber.

Camm's redesign of the P.1005 was assessed by Liptrot in a minute dated 22nd January, the main alteration being a 12% reduction in wing area but with the original span maintained. He expected an increase in top speed to 409mph (658km/h) at 25,000ft (7,620m) but other performance aspects were expected to suffer including a reduction in range by 70 miles (112km), a increase in weight of some 300lb (136kg) and a reduced ceiling of around 1,000ft to 1,500ft (305m to 457m). Liptrot had several objections to the revised wing – structurally it was difficult in regard to torsional stiffness while the poor lift distribution would probably produce tip stalling. He concluded that detailed investigations were needed before it could possibly be accepted; personally, he considered it quite unacceptable and felt some real risks had been introduced.

On 8th January a final decision to select the Hawker P.1005 or the de Havilland DH.101 (below) had been delayed, in part because details of the latter had only just been supplied. But a week later the Air Staff felt it would be unwise to produce both and suggested dropping the P.1005. Early in the following month Liptrot reported that the position of this aircraft had become ill-defined since his department had been informed that its production was cancelled while the provision of a four gun turret was, apparently, only an insurance against the P.1005's performance comparing unfavourably with contemporary enemy aircraft. In fact a note had circulated the Ministry on 4th February saying that the requisition for the purchase of 1,000 Hawker bombers had been withdrawn and, therefore, there was no necessity to prepare a production specification.

Two P.1005 prototypes were ordered with serials HV266 and HV270. A mock-up was built which included at least the engine installations, inner wings and forward fuselage, and the Mock-Up Conference was held on 27th February 1942. On 17th March a final decision on the P.1005 was deferred for six months and one reason for this was that cancellation would upset Hawker because the company understood that orders for 1,000 aeroplanes were likely. These production plans had foreseen the replacement of the original Merlin Mosquito at a rate of 50 per month, although the changeover at Hawker would cost an estimated 700 Typhoons. Just two days later, at an Aircraft Supply Council Meeting, it was agreed that Buckingham production should be 25 a month, as already planned, but no production should be ordered for the Hawker Sabre bomber or the Super Mosquito with Griffons. In both cases prototypes only would suffice and it was felt that the Air Ministry would be ready to abandon the P.1005 because the company's fighter production was not to be prejudiced.

This was the end for the P.1005. Although the fully approved specification finally came through at the end of May, on 10th June the Deputy Controller of Research and Development gave verbal instructions that the order for the type was to be cancelled. A 9th June minute explained that the P.1005's history was unfortunate and fraught with continual delays and vacillations of policy. In truth, no production capacity appeared to be available before about the end of 1944 and so the company was recommended to cease work on the two prototypes. The project was considered to be very promising but was abandoned because of the hopeless production prospects brought about by a shortage of capacity, not through any shortcomings in the design. Much later, in February 1944, Air Marshal Sorley explained that B.11/41 had been planned before the Mosquito had been accepted. Preparing early replacement types was normal practice and a probable reason for the Hawker project not going ahead was uncertainty at the time as to whether the Mosquito would be a success. During the period it had seemed sensible to encourage progress of the Hawker bomber.

No information has been traced detailing the level of progress made on building the two prototypes, but it seems likely that very little was actually done. Considerable problems were experienced with the Napier Sabre (which created difficulties for Hawker's contemporary single-engined fighters) and had the P.1005 been continued this situation might well have affected that project. One wonders if the machine would ever have progressed beyond the prototype stage even with a more favourable production situation. The P.1005 was also offered (prior to April 1942) with Bristol Centaurus radials as the P.1015, which reduced the estimated maximum speed to 390mph (628km/h).

De Havilland DH.99/DH.101

The P.1005's competitors were the Bristol Buckingham, the only type to reach production, and the de Havilland DH.101/DH.102. The Mosquito was eventually built in a host of variants, some of which filled the roles envisaged for the P.1005, but de Havilland's proposal to B.11/41 never actually left the drawing board. As noted, B.11/41 was written around the P.1005 but in the autumn of 1941 DH wanted a more powerful Mosquito and this specification became the design team's target.

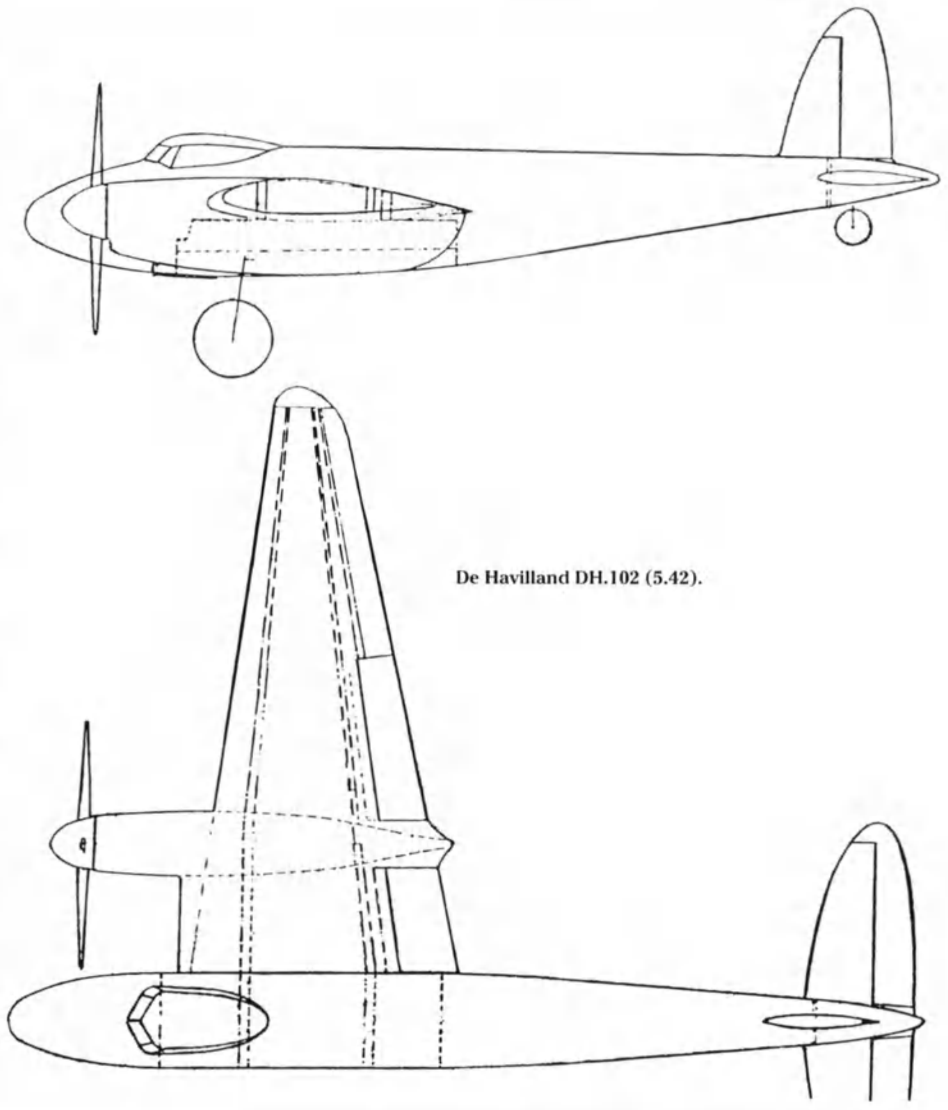
The result was a modified Mosquito with two Sabres which was initially called the DH.99 but then renumbered DH.101; together with the later DH.102 this was known as the Super Mosquito or 'hotted-up Mossie'. Estimated top speed was 417mph (671km/h) at 26,000ft (7,925m) (more powerful Sabre NS.8.SMs of 2,180hp [1,626kW] offered 430mph [692km/h]), 4,000lb (1,814kg) of bombs were carried internally (though not the single 4,000 pounder) together with another 2,000lb (907kg) under the wings, and a new third crewman would act as a navigator. The required 1,750 miles (2,816km) range could be reached by carrying small external tanks – without these but with 6,000lb (2,722kg) of bombs aboard the range was 1,460 miles (2,349km), maximum speed 406mph (653km/h) and ceiling 27,300ft (8,321m) (with NS.8.SMs ceiling would be 35,000ft [10,668m]).

The DH.101 fitted with Sabres allowed the Mosquito's high-speed characteristics to be maintained, but with an increase in dimensions to permit sufficient crew accommodation for accurate bombing. However, on 4th April 1942 the company was notified of the unavailability of Sabre engines for this project and it was advised to use Griffon 61s instead, but the expected lower performance from the latter meant that the project was quickly dropped. In truth the planned production levels for the Sabre were insufficient to make the NS.8.SM available to this new project (or the P.1005) while DH added that it could not employ the Centaurus on the DH.101. The company had also been put off by the talk of fitting the turret onto the P.1005 which was entirely against company philosophy. Work now moved on to the DH.102 bomber.

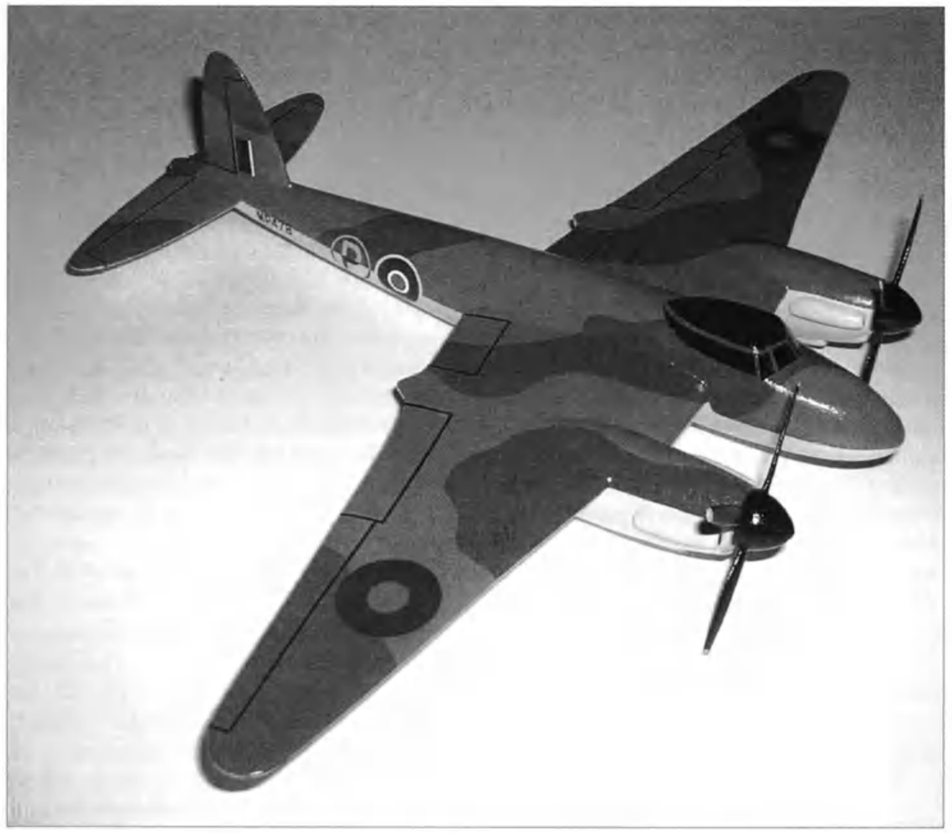
De Havilland DH.102

On 2nd July 1941 Wilfrid Freeman told Linnell 'it was always my intention that the Mosquito should be followed by the Mosquito II built along the same lines but fitted with a Griffon engine'. Linnell replied that 'de Havillands are too full up with getting the original Mosquito going for us to worry them with the II'; nevertheless the DH.99 (DH.101) 'blown up Mossie' project was offered in mid-November 1941. Since neither the Griffon or Centaurus were suited to the DH.101, DH withdrew from the B.11/41 specification and replaced the project with an alternative Merlin 61-powered aircraft, of slightly smaller dimensions, which used the present Mosquito as a basis. This was to be a high-speed night and day bomber and was called the DH.102 – it was similar to the DH.101 in appearance and had a pressure cabin and three crew, but less power. The project was described as a 'Mosquito Replacement' and designated the Mosquito Series II yet, with 5,000lb (2,268kg) of bombs on board and either Griffon or Merlin powerplants, it was expected to be slightly slower than its predecessor. Specification B.4/42 was allocated to the project and the construction of two prototypes, MP478 and MP481, was begun. By October 1942 these were reasonably well advanced but little enthusiasm was felt for the DH.102 either at de Havilland or within the Air Staff.

On 6th November GdH told Linnell that no mention had been made for any production



De Havilland DH.102 (5.42).



of the '102'. There did not seem to be too much interest shown in the type and GdH added that 'tooling and generally preparing for production might have started months ago, but nothing has yet been done. In view of this we cannot feel convinced that the machine is really badly wanted and, therefore, cannot feel much enthusiasm in proceeding with it'. GdH felt that the production of a modified Mosquito in place of the '102' would save time which was important since his company now had the DH.100 jet fighter on its hands (later the Vampire – Chapter 11) and was also considering a single-seat fighter with twin-Merlin 61s (which became the DH.103 Hornet – Chapter 2).

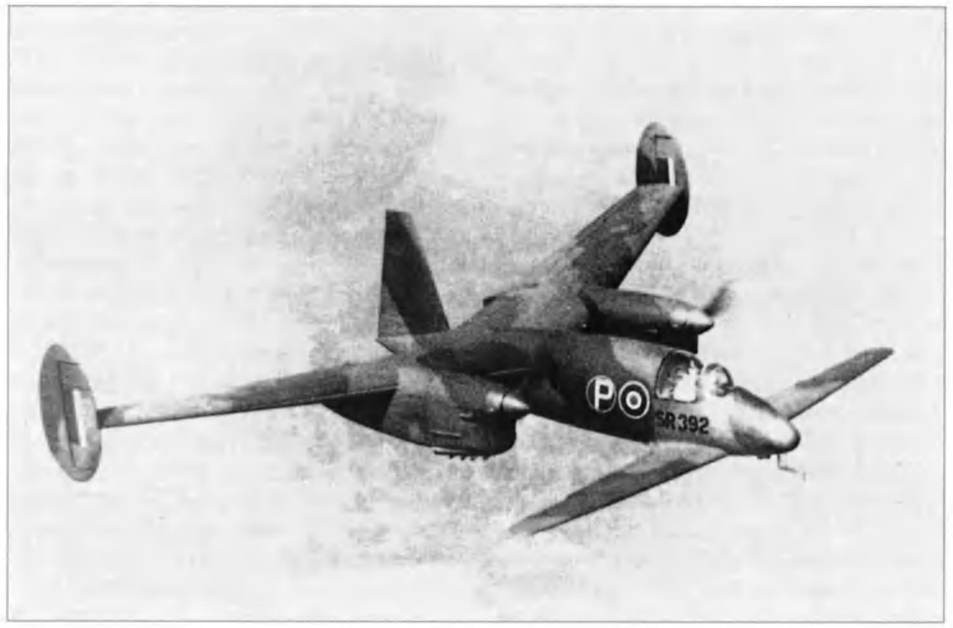
The Air Staff was interested in the twin-Merlin fighter but DH could not undertake that and all of its other commitments, while the company's unease with the DH.102, after sensing doubt in the minds of the Air Staff as to the wisdom of proceeding with it, was noted. After a month deliberating the question of the unarmed bomber, the Air Staff gave instructions to cancel the DH.102 on 26th December 1942 and, as a result, de Havilland reorganised its design staff and began serious work on the more valuable Hornet and Vampire.

Miles M.39

Miles Aircraft also produced a design to B.11/41, in the form of its M.39 Libellula, and this was the only B.11/41 project to generate any flight testing. In 1941 Miles became aware of the high accident rates associated with deck landings on carriers and it was evident that many of the risks were due to the poor forward view in types like the Seafire. The company therefore began some private venture work to investigate the possibilities of evolving an unorthodox layout with the objectives of both improving pilot view and eliminating the complications and time wasting brought about by wing folding. After examining several possible layouts the solution appeared to be a tandem-wing arrangement, provided that it was aerodynamically feasible.

Miles was reluctant to submit a questionable design for official consideration and so decided to build and fly a rough mock-up which became the M.35; it was designed and completed in just six weeks. The first flight was made on 1st May 1942 and, despite experiencing some longitudinal instability, the machine amply demonstrated that the tandem-wing arrangement was perfectly feasible and controllable. The layout was christened Libellula (after the entomological title for the dragonfly family) and proposals for a naval fighter were immediately submitted to the Admiralty and MAP. However, the M.35's flight results were so encouraging that Miles continued its research and moved on to a bomber.

A Libellula project called the M.39 was now prepared to the requirements of B.11/41 and submitted to MAP in July 1942 (after cancellation of the P.1005 which suggests that B.11/41 was really something of a working reference for the designers). In the meantime work also began on the M.39B, a 5/8ths scale flying model which flew on 22nd July 1943. Registered U-0244, the M.39B was powered by two 140hp (104kW) de Havilland Gipsy Major engines, its front wing had a span of 25ft (7.6m) and the rear 37ft 6in (11.4m), length 22ft 4in (6.8m) all-up-weight was 3,200lb (1,452kg) and max speed 164mph (264km/h). Flight trials showed that the machine exceeded all of the desired advantages and, apparently, possessed no disadvantages or undesirable handling characteristics. During this period much interest was being shown in official circles towards the development of unorthodox types in connection with very large aeroplanes.



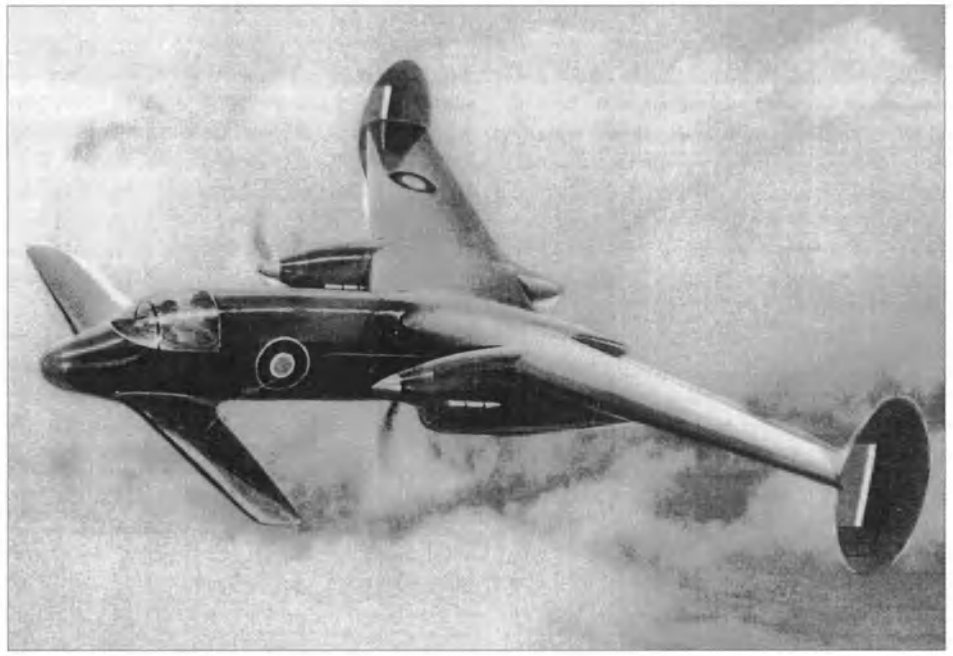
Model of the DH.102. Joe Cherrie

Miles M.39B seen on a test flight after serial SR392 had been allocated.

Briefly the Libellula concept consisted of two wings mounted in tandem and interconnected by a short fuselage. The forward wing always had less area than the rear wing (the proportions for the M.39 bomber were 1:3) and both were fitted with high-lift devices. Some of the benefits of the Libellula form were the attainment of a much greater permissible range of CofG movement than was possible with any orthodox layout, the ability to use high-lift devices to maximum effect on both wings, a reduction in structure weight of a large span single wing compared with two wings of equivalent total area (this was particularly marked on very large aeroplanes), the elimination of weight and drag from tailplanes, elevators and their necessary long fuselage, and the improved view for the pilots of single-engined aircraft; there were also other aerodynamic benefits.

The forward wing was used for longitudinal control and could be combined with Miles' retractable auxiliary aerofoil high-lift flap cum elevator, a feature which helped the exceptionally large range of CofG movement. This not only provided a big range of lift coefficient for the front wing but also allowed the pilot to alter the available wing area with no variation in lift coefficient – in this way the wing area could be varied at will to correspond with the optimum value for any given load condition. It also provided a means of varying the area of elevator available for longitudinal control, which could be varied at will to correspond with any given flight speed – the arrangement was made up of elevators inboard and flaps outboard, both mounted as trailing-edge flaps. The rear wing carried the means of lateral control and could also carry, at its tips, fins and rudders for directional control; the CofG always lay between the two wings. On the M.39 the rear wing carried the flaps inboard and ailerons outboard and it had the tip fins and rudders. (Note: the forward wing on a Libellula design was *not* a canard chosen instead of a tailplane; here both wings acted as lifting surfaces.)

The M.39 had a low forward wing and a high rear wing so that the rear surface was clear of the forward wing's downwash effect and provided good ground clearance for the propellers. It was intended that the M.39 should eventually be powered by three Power Jets W.2/500 units to give a speed of 500mph (805km/h) at 36,000ft (10,973m), but in 1942 these were not yet available and so the alternatives were two high-altitude Merlin 60 or Hercules VIII piston engines (the latter never went into production); the Libellula arrangement made substituting jets for pistons a fairly straightforward operation. The bomber's structure would be all-metal and the three crew were housed in a pressurised cockpit with a bomb bay placed amidships. A tricycle undercarriage was used and two 20mm cannon were mounted in the forward wing roots.



On 16th September 1943 MAP agreed to award a development contract which included the purchase of the M.39B with a new serial SR392. An order for a full-scale M.39 prototype, RR910, was placed in November but this aeroplane was never built. Miles continued to test the M.39B and, armed with the additional flight data that this generated, George Miles resubmitted the project in January 1944 with an improved performance, but again to no avail.

Specification B.7/40 and Bristol Buckingham

In May 1940 Specification B.7/40 was issued for a medium bomber with defensive armament which was intended to replace the Bristol Blenheim. It called for a maximum speed of at least 300mph (483km/h) at 5,000ft (1,524m), a normal load of 1,000lb (454kg) of bombs and a centre turret with at least two 0.5in (13.7mm) calibre machine guns. The following projects were produced after the Issue to Tender was made on 10th July to Armstrong Whitworth, Hawker and Westland, but only AWA actually tendered and its design did not attract the Air Staff. A project produced by Fairey in mid-1940 with twin Merlins may also have been prepared to B.7/40. The requirement was not proceeded with.

Armstrong Whitworth B.7/40

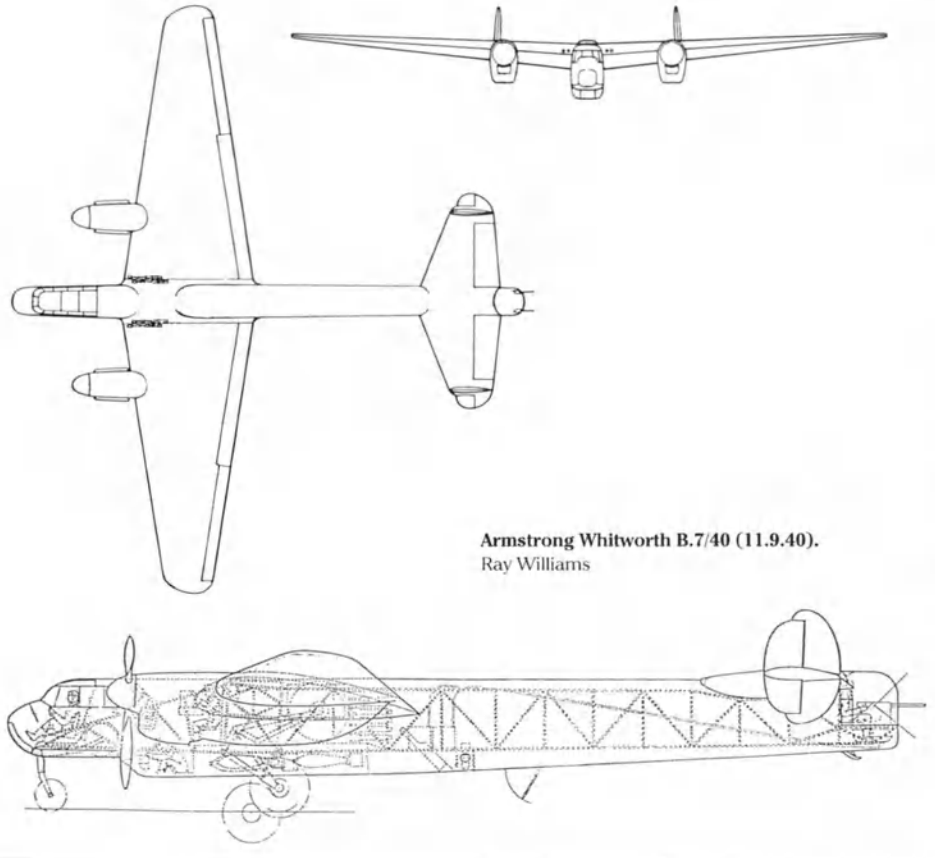
AWA found that it could not meet all of the requirements together without reaching an estimated weight of 26,000lb (11,794kg), which was thought to be excessive to carry such a small bomb load. However the design team's compromise still weighed 24,000lb (10,886kg) and used two Merlins and a mix of steel tube and wood construction similar to the Albemarle. The required 1,000lb (454kg) of bombs was housed in a fuselage bomb bay placed level with the wing roots but another 1,000lb could be loaded externally under the wings. For defensive purposes there were four 0.303in (7.7mm) machine guns in the upper wing roots and a twin 0.5in (13.7mm) tail turret; four crew were carried.

Hawker P.1001

This was a design based on the Henley close-support bomber.

Westland B.7/40

A Delanne type powered by a single Bristol Centaurus which was described by the company as a light bomber. The bombs were car-



Armstrong Whitworth B.7/40 (11.9.40). Ray Williams

ried internally and there were four crew. A rear defensive turret housed four machine guns and, unusually, the sketch suggests that two more were housed in the leading edge of each rear wing.

Bristol 161 and Bristol 162

In January 1939 Bristol proposed a Beaufighter bomber with Hercules engines. In general Air Staff policy was to concentrate British production on heavy bombers because American close-support medium bombers were expected to be available in large numbers. Nevertheless a twin-engine machine was requested with development of an existing type the favoured option. The Blenheim had reached its developmental limit so Bristol was left with only the Beaufort torpedo bomber (Chapter 9) and Beaufighter (Chapter 2) as suitable starting points; the latter being the clear favourite through its performance and versatility. However, the Beaubomber was not well received by the Air Staff and was turned down because it would involve a complete redesign of the internal layout and would also give no advance in comparison with contemporary bombers.

Bristol gradually developed its 1939 ideas through the Type 161 of mid-1940 into the Type 162. The 161 was proposed in two versions, a high-altitude medium bomber with a dorsal turret and four 0.303in (7.7mm) plus two more rearward-facing machine guns beneath the forward fuselage, and an army support aircraft in which the bomb load and the lower guns were replaced by two 20mm cannon. However, constant changes of requirements led to the design maturing into the 162 which was tentatively named Beaumont. By autumn 1940 B.7/40 had failed to bring forward any design that was considered suitable for construction and so when Bristol sent in its new proposals for the Type 162 Beaumont on 2nd October, which fitted B.7/40's requirements closely, the Air Staff was ready to discuss them. The 162 had the rear fuselage, tailplane, fin and rudder of the Beaufighter Mk.III, but an entirely new front and centre fuselage for which a mock-up was built (the prototype Type 158 slim-fuselage Beaufighter Mk.III was never completed). An alternative drawing showed a straightforward way of making use of the majority of the existing tooling from the Beaufort and Beaufighter on a design that was identical to the Beaufighter Mk.III and IV.

Capt Liptrot's assessment, completed on 17th October, noted that operationally the 162 was by far the better layout since the crew were grouped compactly, but it had the disadvantage that the wings would not remain standard and a new undercarriage was required. Liptrot concluded that the proposal could result in a very useful bomber but he did feel that its landing distance was too long for a type which would have to operate in support of the Army from poor quality advanced aerodromes.

The Beaumont had four 0.303in (7.7mm) machine guns in a mid-upper turret, two more facing rearwards under the fuselage and four more in a fixed forward turret. A crew of three was specified and Merlin 5.SMs were an alternative engine which Liptrot calculated would give a maximum 305mph (491km/h) at 15,000ft (4,572m). Following a meeting between the Air Staff, MAP and Bristol in November, this development of the Beaufighter into a medium and direct support bomber received a go ahead together with a request to complete the mock-up. Another Air Ministry meeting, held on 3rd January 1941, decided that twin rudders would be satisfactory while on 2nd February Sir Henry Tizard gave authority for a formal contract for three prototypes.

The decision to ask Bristol to complete the Beaumont mock-up after which the Air Staff and MAP would confirm the design as a requirement, and write a new specification (B.2/41) around it, was the reverse of the normal procedure to circulate specifications for tender. Construction of the Hercules Beaumont began in November 1940 with the first flight expected in summer or autumn 1941 but many requirement and design changes interfered with the aircraft's progress. The initial demands had covered bombing, dive bombing and direct army support but the last pair were cancelled in March 1941 since the Air Staff felt the American Brewster Bermuda and Vultee Vengeance aircraft would fill these roles. At the same time there was anxiety to improve the performance because full production was two years away and current estimates would then have been bettered by new American products. Increases in speed (to 360mph [579km/h]), bomb load (4,000lb [1,814kg]) and range (1,600 miles [2,574km]) needed more power than the Hercules could provide and Bristol was asked to redesign the project with the Centaurus.

Bristol 163 Buckingham

A new layout with a larger wing called the Type 163 Buckingham was accepted in March 1941 with a planned first flight in May or June 1942; all trace of the aircraft's Beaufighter origins were gone and Bristol was thinking of an aircraft weighing 29,000lb (13,154kg). The capability to carry a torpedo was introduced as a secondary requirement but in January 1942 this aroused much controversy at Cabinet level. The idea was raised that the near obsolescent Beaufort could be replaced by the Buckingham but this was strongly opposed by the Admiralty who felt adapting a bomber for this task was always considered second best while the machine's comparative high speed made it unsuitable for such an adaptation. This plan was dropped six months later. B.2/41 was approved in August 1941 but more design and requirement changes led to its abandonment in spring 1942 to be replaced by B.P/41 (later I/P1) which covered both prototype and production machines. On 25th November 1941 Bristol began building the Buckingham prototype and the first flight date was set at November 1942, which displeased N E Rowe who wanted it in the air two months earlier.

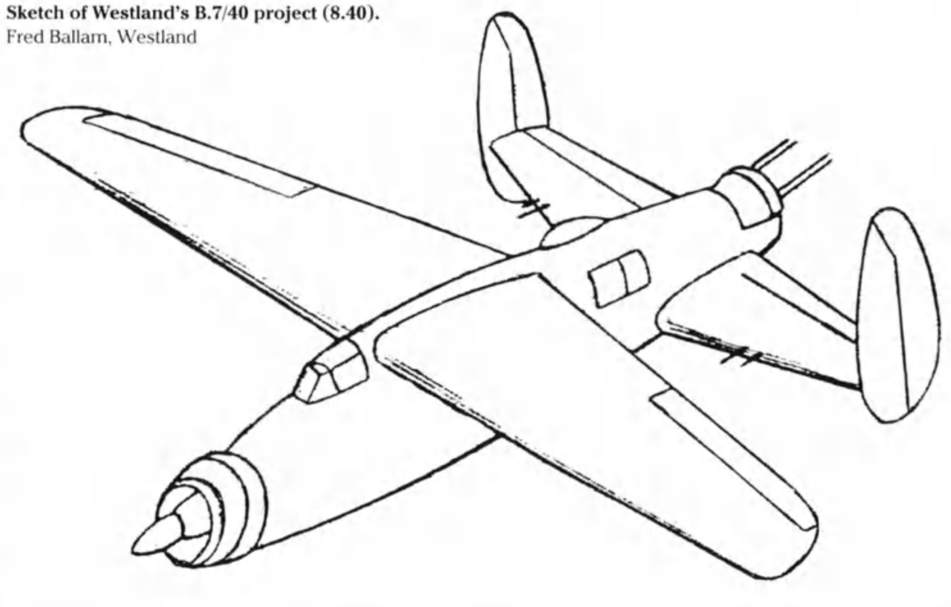
A fourth prototype was confirmed on 12th May 1941 but no decision was taken on production. Discussions at the highest level dragged on through 1941 and 1942 as to whether a medium bomber was still required operationally and to how its production would fit into existing programmes; any loss in production of heavy bombers for example was considered unacceptable. At one stage this indecision forced Bristol to complain that it was losing interest in the project and to request more 'practical' interest from MAP. On 18th September 1941 VCAS told CAS that he 'should like to place an order for 400 Buckinghams now. Unless we introduce a new type of medium bomber into the production system without delay the lack of such an aircraft will be a serious gap in our forces in 1943/44. MAP will, of course, attempt to choke us off by depressing estimates of the effect on present production. Every time this problem has been put to them in the past they have done the same thing and it is about time they faced up to the vital necessity for planning new, as well as continuing existing, production. If they do not, there is a great danger that in the future we shall have quantity without quality.'

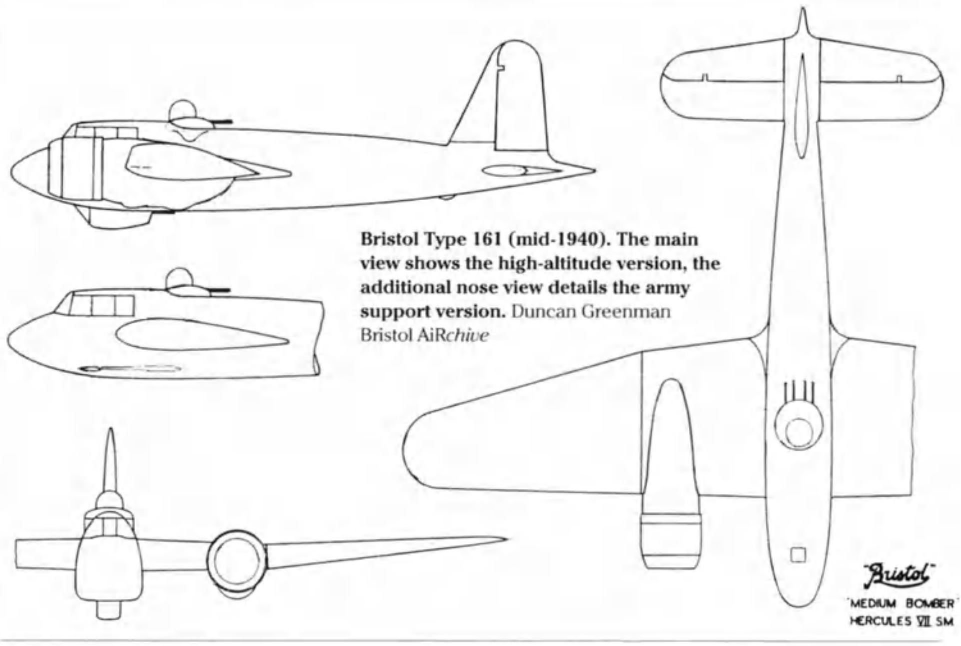
In November an order was placed for 400 Buckinghams with the first delivery due in March 1943 (this target was actually missed by nearly a year) but the initial planned production rate of 50 or 60 a month was then lowered to 25, a step that caused Bristol to express further discontent. The company felt that if the Buckingham was a worthwhile aircraft, this was insufficient to maintain a reasonable scale of operations; on the other hand, if the aeroplane was just an interesting development, this was far too expensive. Bristol complained of 'half hearted planning, the inadequacy of which is realised too late'. However, delays to the prototype's completion were also partly due to the manufacturers and to technical problems.

The first Buckingham prototype, DX249, became airborne on 4th February 1943. One task earmarked for the type, in company with the Mosquito, was to press home daylight attacks on the enemy's heavy industry. However, the night bombing offensive against Germany was made effective by the use of radar navigational aids and with the US Eighth Air Force taking on the daytime work, the need for an additional day bomber fell away. It was felt that the Buckingham's armament and speed did not qualify it for use on unescorted day operations in North West Europe and at the beginning of 1944 it was decided that all Service aircraft would go overseas to replace Vickers Wellingtons; none were to equip home based squadrons except for a proposed operational trials unit to get the bugs out of the system.

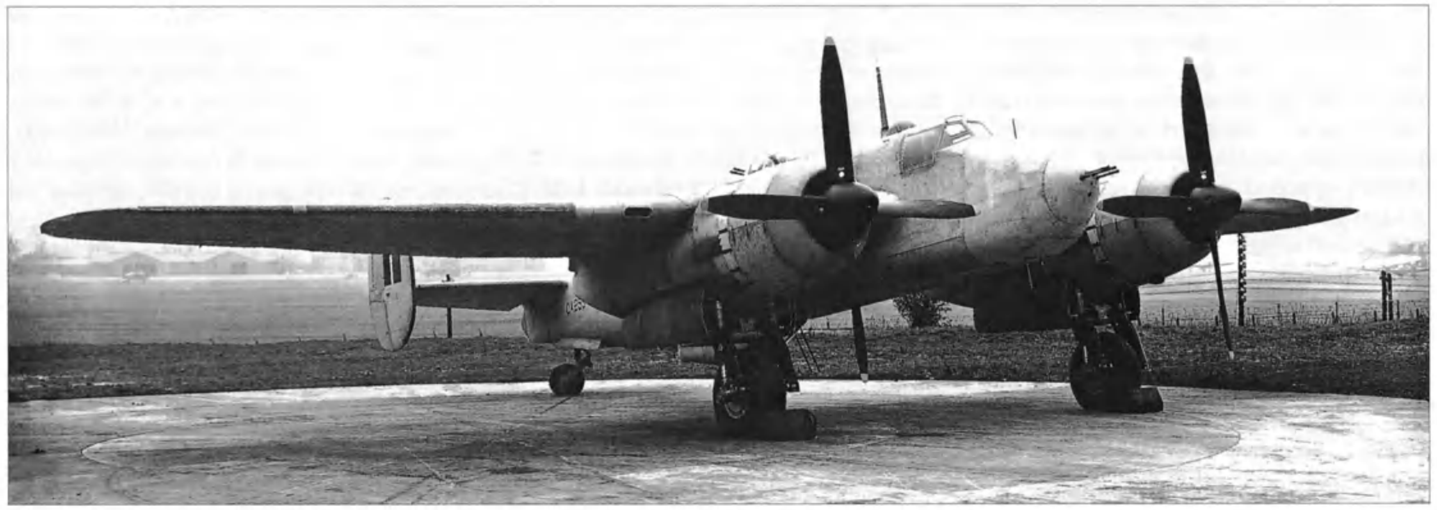
When a report was submitted that detailed some severe problems uncovered during flight testing at A&AEE, with criticism extending to nearly every feature of the bomber's layout from an operational point of view, the programme was seriously reconsidered. The potential value of the aircraft and the need for its production was questioned and in August

Sketch of Westland's B.7/40 project (8.40). Fred Ballam, Westland





Bristol Type 161 (mid-1940). The main view shows the high-altitude version, the additional nose view details the army support version. Duncan Greenman Bristol AIR*chive*



View of the second prototype Bristol Buckingham DX255 taken at Filton on 6th November 1943. This machine was employed on test flying at Boscombe Down during most of 1944 before being scrapped in November of that year; it was the first aircraft to receive the full armament. David Charlton, BAe Filton

1944 the decision was made that there was no operational use for the type in the RAF in either bomber or PR versions; DCAS, N H Bottomly, recommended that production should be stopped at the earliest practicable stage. As a tactical bomber the Buckingham was unusable and pressure was to be directed at obtaining alternative American types to meet No 2 Group's requirements.

Following the cancellation an assessment of the repercussions to the overall production programme found that a minimum of 119 Buckingham bombers would still have to be manufactured to keep the labour force together to produce later on both the Brigand torpedo bomber (Chapter 9) and Hawker Tempest fighter. It was realised that these Buckinghams would be virtually useless aircraft and, as soon as they were released by CRD, every effort was to be made to find them employment in miscellaneous units. Fitting equipment, and even engines, was seen as wasteful and it was decreed that the aircraft were to be stored until employed or authorisation was given to reduce to produce.

Consequently much thought went into making something from what was now a worthless programme and the result was a high-speed transport or 'courier aircraft' conversion. Rowe told Bristol that the Air Ministry wanted bombers turned out as communications aircraft with space for four passengers behind a crew of three. Combat equipment, armour and turrets were stripped out with the seating fitted by hand, the fuel load was increased to 1,500gal (6,819lit) by putting long-range tanks in the bomb bay and the prototype conversion, KV338, first flew on 21st October 1944. Only 54 Buckinghams were delivered as B Mk.1 bombers, the remainder appearing as C Mk.1 transports.

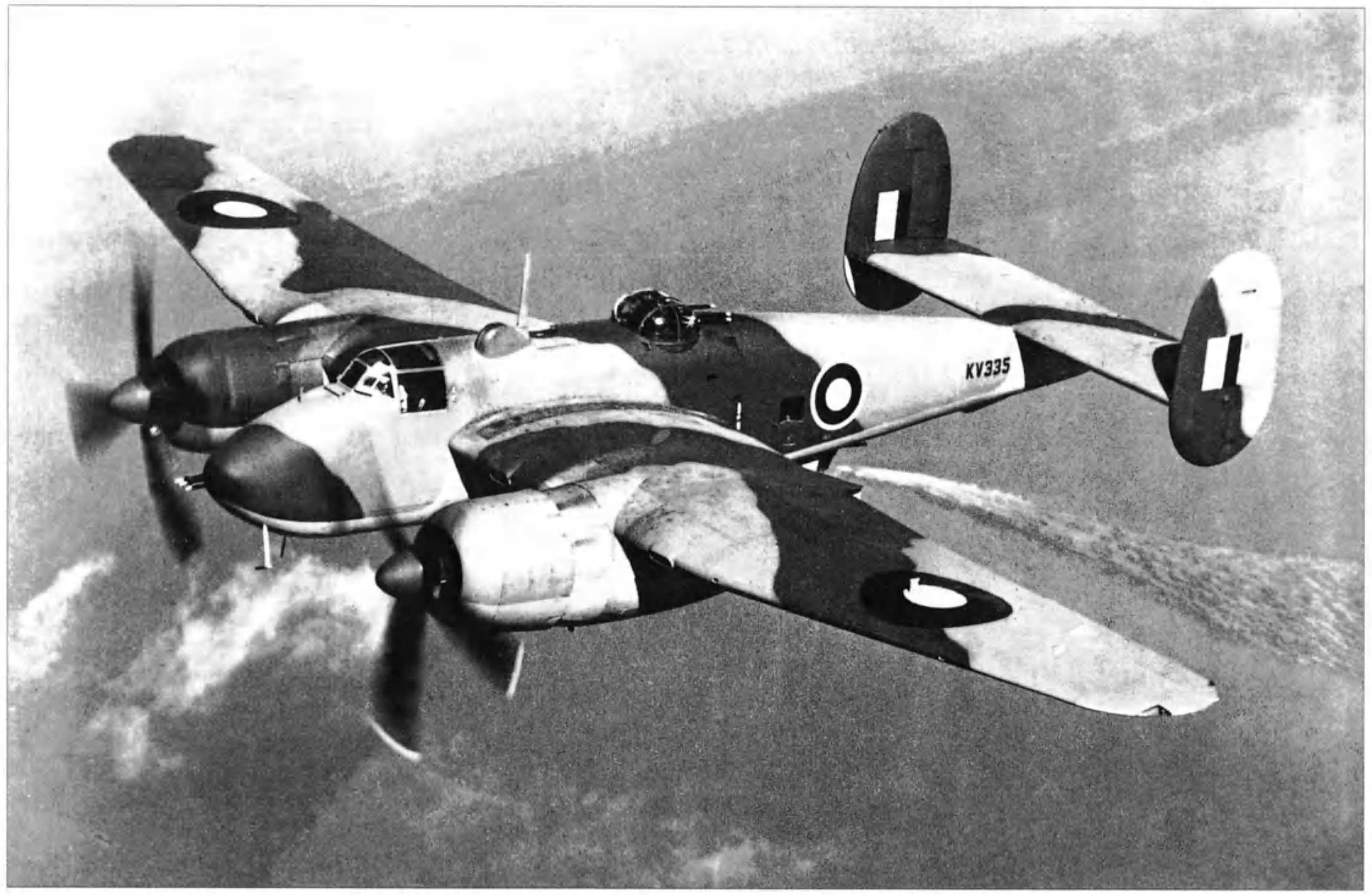
Most series aircraft were flown direct to store at RAF Maintenance Units where they survived only a few years before breaking up. None saw squadron service and almost all had short flying lives, although a select few did find employment on test duties. One result was the realisation that service pilots would find it quite taxing to convert to the bomber, so a special trainer variant was prepared called the Type 166 Buckmaster. This involved removing the Buckingham's front fuselage and substituting a new one with full dual control and side-by-side seating; the rest of the structure was near identical to the Buckingham. Two prototypes, TJ714 and TJ717, were converted from partially complete Buckinghams, the first flew on 27th October 1944 and 110 were built as trainers for the Brigand.

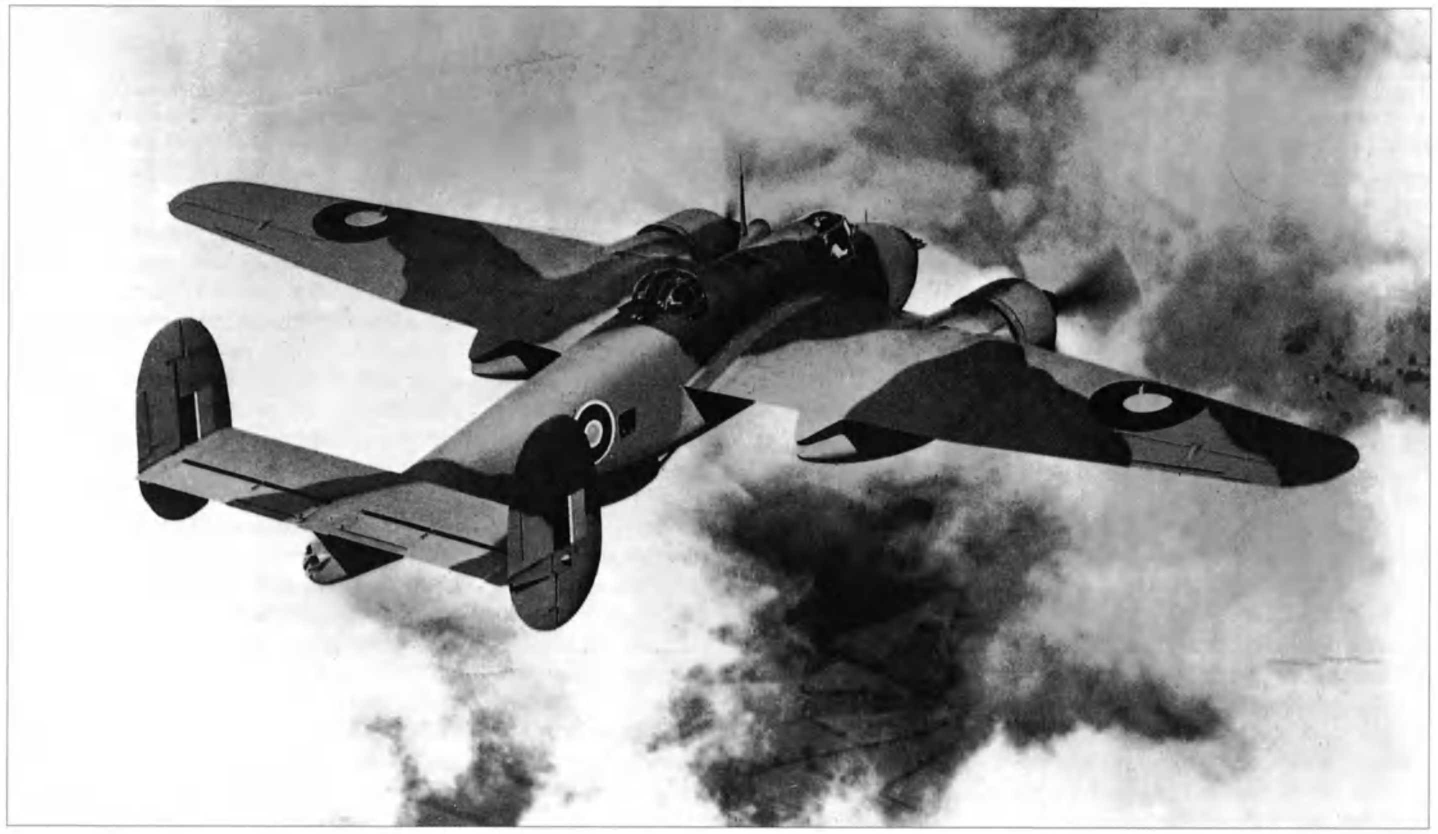
As a postscript, it is interesting to look at some notes from an interview made on 18th February 1944 with Air Marshal Serby, CRD. The Buckingham originated when forward thinking was allowed to restart in 1941 (following the 'hold' on new designs introduced by Lord Beaverbrook at MAP during the Battle of Britain) but also when the four-engine bomber, a type considered better operationally, was being introduced. He noted that Air Marshal Sorley felt the day of the medium bomber was over and Serby had only forced the Buckingham forward because no other replacement was in sight for the 1945/46 period; rejecting this aircraft would have been tantamount to a decision to cancel the entire class of medium bomber. Sorley considered the medium class had reached its limit and had no further use, but the general view was that it could still fill some squadrons overseas. For close-support work he now favoured the fighter bomber. Although Air Marshal Tedder had used medium bombers in big numbers in the Mediterranean theatre, their results when compared to those of fighter bombers were inferior.

The Buckingham fulfilled expectations as to bomb load and range but it was down on speed when compared with fighter bombers and could never achieve a high performance (the long gestation period meant that it was rather overtaken by the Mosquito). One Ministry memo described it as something of a hybrid – it was too small to carry either adequate defensive armament for daylight operations or suitable equipment for accurate bombing at night, so it was limited to daylight work in formation under strong fighter cover.

The great advances made in the Second World War to the capability of aircraft and weaponry forced operators to redefine the categories of the aircraft that they used. At the start of the conflict the medium bomber was typified by the Wellington which was capable of medium range but with the capacity to operate elaborate equipment for accurate day and night navigation and target location; by the mid-war years the Wellington was considered to have merged into the 'heavy' bomber category. Types such as the Buckingham were also classed as medium bombers but later on they could be more accurately described as tactical bombers. The Americans built aircraft of this class in large numbers and many examples of the Martin B-26 Marauder and North American B-25 Mitchell were also bought for the RAF.

Opposite page: **Buckingham B Mk.1 KV335 was used for test purposes at Filton during the winter of 1944/45; these shots were taken on 20th April 1945.** David Charlton, BAe Filton





Medium Bombers – Estimated Data

Project	*Span* *ft in (m)*	*Length* *ft in (m)*	*Gross Wing Area* *ft^2 (m^2)*	*Max Weight* *lb (kg)*	*Engine* *hp (kW)*	*Max Speed / Height* *mph (km/h) / ft (m)*	*Armament*
AWA AW.41 Albemarle (flown)	77 0 (23.5)	59 11 (18.3)	803.5 (74.7)	36,500 (16,556)	2 x Hercules XI 1,590 (1,186)	264 (425) at 14,000 (4,267)	4,500lb (kg) bombs max, 4 x 0.303in (7.7mm) mg
High Speed Unarmed Bombers							
Handley-Page High Speed P.13/36	88 6 (27.0)	71 6 (21.8)	988 (91.9)	24,608 (11,162) with 3,000lb (1,361kg) of bombs	2 x Vulture	380 (611)	7,000lb (3,175) bombs max
de Havilland Mosquito Mk.IV (flown)	54 2 (16.5)	40 9.5 (12.4)	454 (42.2)	21,462 (9,735)	2 x Merlin 21/23 1,480 (1,104)	341 (549) at 20,000 (6,096) at 17,000lb (7,711kg) mean weight	4,000lb (1,814kg) bombs max
Specification B.11/41 & B.4/42							
Hawker P.1005	70 0 (21.3)	54 0 (16.5) c51 0 (15.5) as fighter	677 (62.9)	31,255 (14,177) norm, 34,000 (15,422) o'load	2 x Sabre IV 2,180 (1,626)	400 (644) at 25,000 (7,620)	4,000lb (1,814kg) bombs, optional turret 4 x 0.303in mg; Fighter 6 x 20mm cannon
de Havilland DH.101 (* = MAP estimate)	70 0 (21.3)	?	710 (66.0)	33,650 (15,264)*	2 x Sabre	417 (671) at 26,000 (7,925)	6,000 (2,722) bombs max Fighter 4 x 20mm or 4 x 40mm cannon
de Havilland DH.102	?	?	?	?	2 x Merlin 61	c400 (644)?	5,000lb (2,268) bombs
Miles M.39	forward wing 37 6 (11.4) rear 55 9 (17.0)	35 10 (10.9)	forward wing 139 (12.9) rear 417 (38.8)	26,750 (12,134)	2 x Merlin 61	'cruise' 360 (579)	6,000lb (2,722kg) bombs
Specification B.7/40							
AWA B.7/40	72 0 (21.9)	61 3 (18.7)	?	24,154 (10,956)	2 x Merlin	300 (483)	2,000lb (907kg) bombs, 4 x 0.303in (7.7mm) plus 2 x 0.5in (12.7mm) mg
Westland B.7/40	52 0 (15.8)	?	360 (33.5)	16,200 (7,348)	1 x Centaurus 2,150 (1,603)	290 (467) at 5,000 (1,524)	1,000lb (454kg) bombs, 8 x machine guns
Bristol 162 Beaumont	?	?	503 (46.7)	21,800 (9,888)	2 x Hercules VII	315 (507) at 15,000 (4,572)	1,000lb (454kg) bombs, 10 x 0.303in (7.7mm) mgs; For close support 2 x 20mm cannon plus 6 x 0.303in mgs
Bristol 163 Buckingham B Mk.1 (flown)	71 10 (21.9)	46 10 (14.3)	708 (65.8)	38,920 (17,654)	2 x Centaurus VII 2,400 (1,790)	337 (542) at 14,400 (4,389)	4,000lb (1,814kg) bombs, 10 x 0.303in (7.7mm) mgs

Chapter Six

Heavy Bombers Part I

Lancaster LM418 of No 619 Squadron was photographed in December 1943. This aircraft was wrecked on 31st March 1944.

During World War Two the heavy bomber was to become the RAF's main offensive weapon and by the end of the conflict its bomber force was incredibly powerful and capable. As a weapon of war this was of immense strategic value but it had taken years of effort and pain, and casualties, to put together. The first seeds were sown by two specifications laid down in 1936 for medium and heavy bombers, P.13/36 and B.12/36 respectively, at a time when the heavy bomber category was represented by the Handley Page Heyford and Fairey Hendon, the latter just entering service. What constituted a heavy bomber in 1936 was rather smaller than its equivalent in 1945; both the size and destructive power of such beasts was to grow enormously in the intervening and very eventful years. Prior to those two requirements, however, there is an earlier specification to examine briefly.

Specification B.1/35 Vickers Warwick

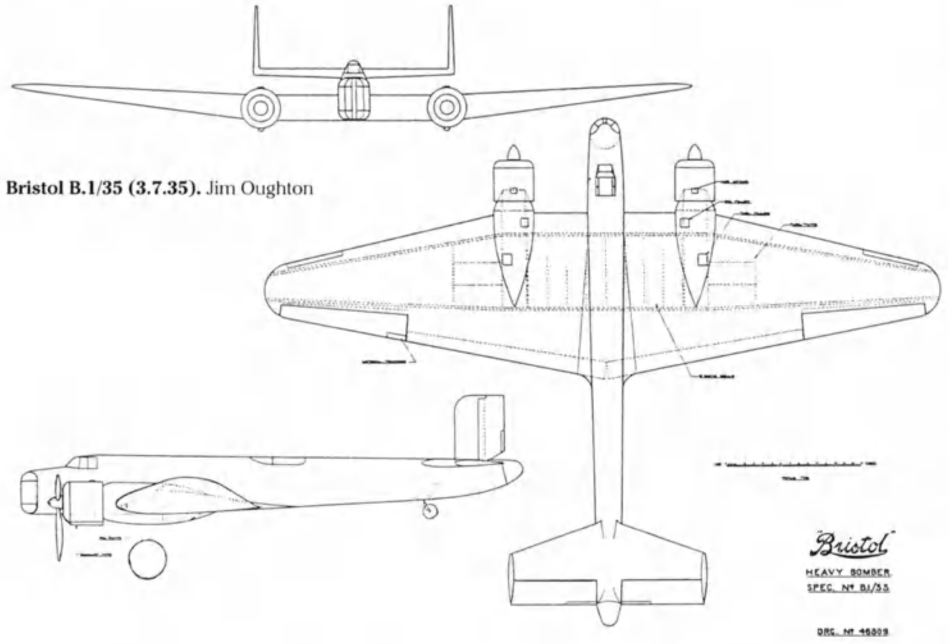
Vickers Wellington and Armstrong Whitworth Whitley

The ancestor of the Warwick was the very successful Wellington, whose story goes back to Specification B.9/32 for which an Issue to Tender was made on 17th September 1932. That programme falls outside the scope of this book but the requirement was won by the Handley Page HP.52 (later to enter service as the Hampden) and the Vickers 271; the single Type 271 prototype, K4049, flew on 15th June 1936. Then in July 1934, following the lapse during the previous month of the weight limit imposed on heavy bombers by the Geneva Convention, heavy bomber Specification B.3/34 was issued. This was won by the Armstrong Whitworth AW.38, which first flew on 17th March 1936 and entered service as the Whitley.

Vickers was also asked to tender to B.3/34 but the company felt that there was no point in doing so since, at the time, it was engaged on redesigning the B.9/32 to scale it up to a size which embraced practically all of the requirements of the new document. The first production Wellington was flown in December 1937 and manufacture of this type was maintained throughout the duration of hostilities up to October 1945, by which time 11,461 had been completed. The Wellington proved to be a most adaptable type and was the subject of a stream of evolutionary modifications, but a key feature of its success was its geodetic structure, which was also used on the Warwick and the Windsor (Chapter 7).

The geodetic method of construction had been developed by Barnes Wallis for the R.100 airship and had also been used on the Vickers Wellesley bomber first flown on 19th June 1935. It comprised a framework of spirally crossing members that formed a latticework structure, the members being in tension or compression, to give a very strong and light airframe which was then fabric covered. The design was based on the principle that two geodetic arcs could be drawn to intersect on a streamlined surface in such a way that the

Vickers Wellington Mk.III X3763. Eric Morgan



Bristol B.1/35 (3.7.35). Jim Oughton

torsional loads on each arc would cancel out that of the other. Wallis was the designer of the Wellington, Warwick and Windsor bombers and the famous 'bouncing bomb' used to break the Ruhr dams in 1943.

In January 1935, on the recommendation of DTD, a new twin-engined heavy bomber specification B.1/35 was drafted. Like many British aircraft designers, DTD had recently visited America and was determined that the latest engineering techniques should be incorporated in new aircraft. In particular he wished to take advantage of new more powerful engines currently under development and these factors combined to make possible an increase in speed from B.3/34's 205mph (330km/h) up to 230mph (370km/h), together with a heavier bomb load. B.1/35 was formally issued to industry on 29th May 1935 and on 30th July a Tender Design Conference was held to analyse eight projects.

The Armstrong Whitworth AW.39 was a development of the Whitley with twin Merlins in streamlined nacelles or, alternatively, two of the new Armstrong Siddeley Deerhound power units; its span was 84ft (25.6m), length 71ft 6in (21.8m), all-up-weight 23,950lb (10,864kg) and top speed 260mph (418km/h). Boulton Paul submitted a version of its P.79 (originally proposed to B.3/34) and Handley Page the HP.55 which had either two Hercules or Merlins, a span of 95ft (29.0m), length 65ft 3in (19.9m) and top speed 251mph (404km/h). There were also designs from Bristol, Fairey, Gloster, and Vickers while, in February 1936, Airspeed added a four-engined bomber called the AS.29 which was prepared to B.1/35 but, of course, was not part of the official competition. The Vickers 284 was derived from the B.9/32 Wellington on a slightly larger scale and fitted with two Bristol Hercules HE.1.SM engines.

The Tender Design Conference gave first place to the Vickers 284 whose construction was simplified through its close similarity to the Wellington. DTD also recommended ordering one prototype each from Handley Page and Boulton Paul, whose designs had reached a high standard. CAS, however, was particularly anxious that AWA's project should be given a chance and the final choice, of which single prototypes of each were ordered on 7th October 1935, was Vickers (serial K8178), AWA (K8179) and Handley Page (K8180). The orders for the last pair were, however, cancelled on 4th March 1937 before the prototypes were complete.

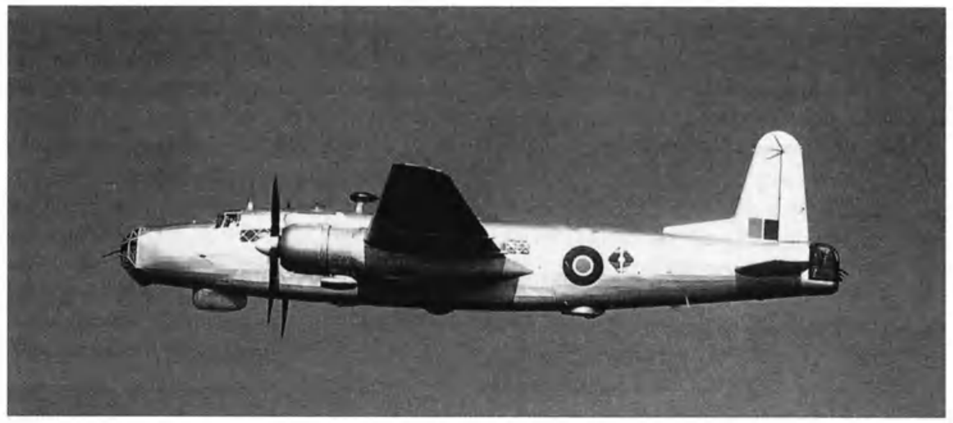
The reason for the cancellations was essentially due to the appearance of specifications B.12/36 (heavy) and P.13/36 (medium bomber) in 1936 (both described shortly); AWA tendered the AW.42 to the former and Handley Page the HP.56 to P.13/36. On 31st August 1936 AWA's Mr Spriggs visited Wilfrid Freeman, AMRD, to discuss his company's workload, which included prototypes of the F.9/35 fighter and B.1/35 bomber. The latter's delivery was promised for April 1937, but in fact it was still in the design stage and unlikely to be flying before December 1937. Spriggs added that unless one of these contracts was cancelled, AWA would be unable to undertake the design of the B.12/36. Freeman added that the F.9/35 was unlikely to be flying until June 1938 which meant that it might be out of date before it was delivered. However, he felt disinclined to cancel either of the contracts 'as there is a tendency amongst aircraft manufacturers to take on more work than they can possibly compete with, then to get the order cancelled as soon as it suits them to do so'. He told DCAS that he wished to tell Spriggs that he must deliver these two aeroplanes and strengthen his design staff so that he could make the fullest possible use of John Lloyd's designing capacity.

Soon afterwards, on 22nd September, Handley Page wrote to DTD, J S Buchanan, to report how investigations had shown 'that an aircraft built to meet P.13/36 as regards overall dimensions and general arrangement would be similar to the B.1/35 type'. Handley Page proposed to redesign the present B.1/35 (the HP.55) to conform to P.13/36 and to stop work on the B.1/35. On 12th October Buchanan wrote 'this is very disconcerting; the B.1/35 was first started nearly two years ago and very little has been done in spite of the promises of the constructors that they could, and would, accelerate the production of experimental aeroplanes'. Buchanan had spoken to Rex Pierson at Vickers and he wished to continue his B.1/35 bomber. However, at this time the Wellington had still not been tested by A&AEE and should the AWA and Handley Page B.1/35s be dropped, the future of the heavy bomber would depend on the success of the Wellington and Wallis' geodetic construction. In addition, because of the planned tender competitions, AWA and Handley Page were not guaranteed orders for their modified designs. In the end the two B.1/35 projects were dropped, AWA and Handley Page having both concluded that it might be a very good thing to abandon them and proceed with more modern aeroplanes. The Vickers Warwick's subsequent career suggests that these were probably sensible steps.

The construction of the Vickers 284, afterwards known as the Warwick, was to prove very protracted, partly through Vickers' work on the B.9/32, partly through the engine supply situation and partly through the official view that this project, as a heavy bomber, tended to be eclipsed by other subsequent designs. During 1936 the fuel and bomb carrying requirements were raised and in January 1937 alternative Rolls-Royce Vulture power units were discussed; later the Napier Sabre was to join the possible engine list. The switch to Vultures in lieu of Hercules was made the following December and K8178 made its first flight on 13th August 1939 with these engines; the second Warwick, L9704, followed on 7th April 1940 with Bristol Centaurus units and, at this time, the decision was also taken to discontinue work on the Sabre mounting since insufficient engines would be available. In March 1939 Vickers had quoted for the Hercules Warwick a maximum speed of 288mph (451km/h), for the Vulture 332mph (534km/h) and for the Sabre 340mph (547km/h), each with an overload weight of 36,000lb (16,330kg).

On 16th February 1939 the decision was taken not to take the aircraft beyond the prototype stage, specifically because of the high level of man-hours needed for the Vulture, but the move was reversed in January 1940. A switch was then made to the Centaurus but this too was in short supply. Finally, in July 1941, L9704 made another maiden flight, this time with American Pratt & Whitney Double Wasp units which completed the aircraft's fifth alternative engine installation; however in this form its performance was inferior to the Centaurus. Nevertheless a contract for 250 Double Wasp-powered aircraft was placed in December 1940 and 57 were built as bombers while later examples were equipped for Air Sea Rescue duties. As finally delivered the Warwick was a great disappointment and, as a bomber, A&AEE classed it as a failure. A switch to service as a transport and in the air sea rescue role was not so much a further development but became necessary because of the type's shortcomings as a bomber. Later production Warwicks reverted to the Centaurus.

When K8178 had first flown the aircraft was two years late and because the later heavy bomber designs had surpassed the Warwick in performance, B.1/35's requirements were by then redundant and obsolescent. The Air Ministry only permitted the type's development to proceed because it wished to have a



LM789 was a Vickers Warwick GR Mk.V general reconnaissance aircraft powered by Bristol Centaurus engines.

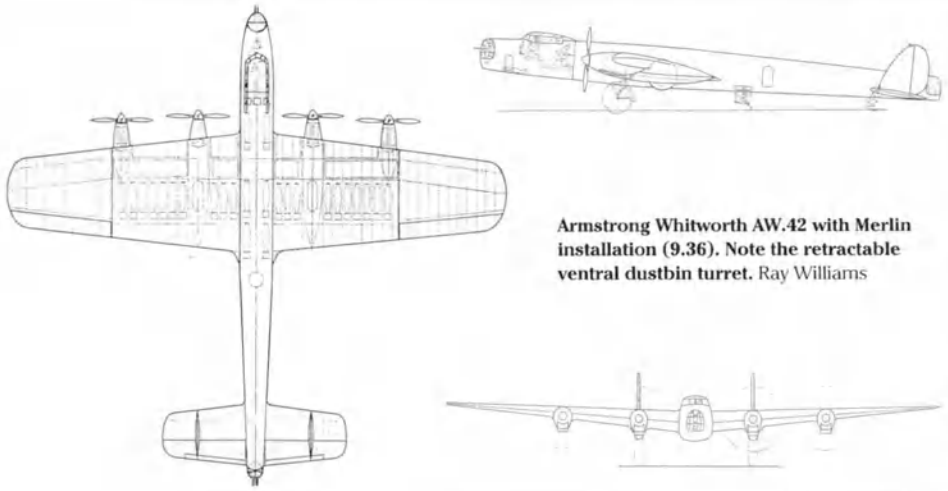
In 1944 L9704, originally the second Warwick prototype, was used to test some remotely-sighted twin barbette defensive guns mounted in the rear of the engine nacelles and which were intended for the four-engined Windsor bomber. The tail turret was replaced by the sighting position. Eric Morgan larger version of the Wellington while considerable production advantages were expected to accrue from the use of common parts (the number proved to be much lower than hoped for). On 14th December 1942 R S Sorley, ACAS(T), told the Secretary of State for Air that 'the Warwick is of no operational value because it has such an unsatisfactory power to weight ratio that it has no ability to fly on one engine with any useful load. This is a basic failing of heavy twin-engined aircraft and is no more attributable to the fact that it is the Warwick than in any other similar sized aircraft. In summary the Warwick fails because it is an old design founded on an unsound basis, i.e. heavy twin-engined aircraft.'

The Warwick was rather unlucky with its engines, but it can also be seen that had the bomber been of more importance to the RAF, it would have had a greater claim on the existing supply of engines. Originally intended as a replacement for the Wellington, when fitted with Vultures it became a more satisfactory replacement but also competed with the Avro Manchester (below) and was inferior to the four-engined types that followed; in truth it was a carry over from the earlier generation of bombers. The Warwick did not enter production until 1942 having lingered on as an extra heavy bomber until other roles were found for it.

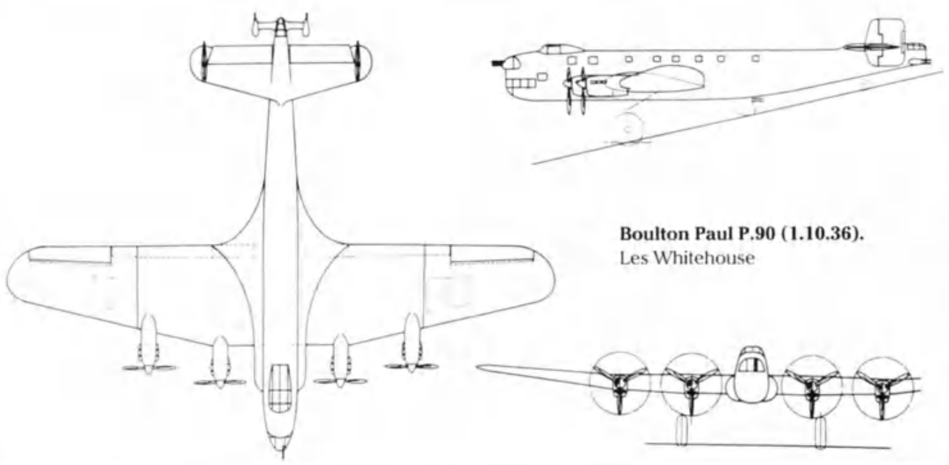
Specification B.12/36
Short Stirling

During the mid-1930s the Air Staff developed the concept that the heavy bomber would be its best weapon for both offensive and defensive operations. However, if such aircraft were to be used as an independent striking weapon they would require a greater range and carrying power than the medium and heavy bombers then under development. Fortunately recent advances in aero engines and aircraft engineering brought these objectives within reach and in 1936 two new specifications were produced, B.12/36 and P.13/36, the former calling for a bomb load of 8,000lb (3,629kg) and a range of 3,000 miles (4,827km) or a maximum load of 14,000lb (6,350kg) coupled with a 2,000 mile (3,218km) range. This bomber's cruise speed at 15,000ft (4,572m) had to be at least 230mph (370km/h) and defensive guns were to be carried in nose, amidships and rear turrets. Both specifications also called for catapult equipment to allow their aircraft to take off with heavy bomb and fuel loads when using existing engines.

In July 1936 B.12/36 was forwarded to AWA, Boulton Paul, Handley Page and Vickers, and the companies were told that in due course they would be invited to tender. Shorts was not on the original list but it was recommended that this company should also be invited to tender because it had a design on the drawing board which met most of B.12/36's limits. In addition, after its amalgamation with Harland and Wolff in Belfast, Shorts had ample drawing office staff and production facilities. B.12/36 was issued to industry in August.



Armstrong Whitworth AW.42 with Merlin installation (9.36). Note the retractable ventral dustbin turret. Ray Williams



Boulton Paul P.90 (1.10.36). Les Whitehouse

Armstrong Whitworth AW.42

This project was offered with various alternative powerplants including the Merlin or Vulture from Rolls-Royce or the Armstrong Siddeley Deerhound. A total of 41 500lb (227kg) bombs could be carried, twenty in side-by-side wing cells between the outboard engines and another 21 in the fuselage; two 0.303in (7.7mm) machine guns were mounted in a nose turret, four more in a tail turret and another two in a retractable ventral 'dustbin' turret.

Boulton Paul P.90

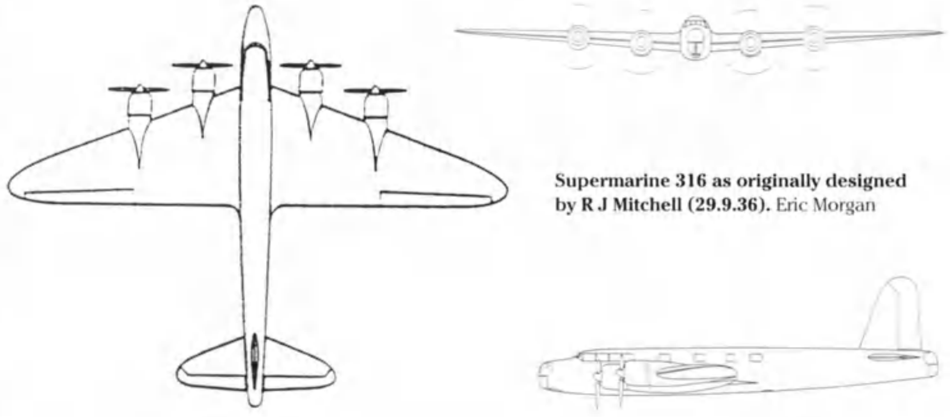
This used an all-metal and mainly light alloy skin structure of the type successfully developed for the P.82 Defiant fighter. The fuselage was monocoque and the tailplane was rigidly bolted to the rear fuselage so that, from the point of view of stiffness and strength, it was virtually integral with the fuselage. The wing was constructed throughout in light alloy and had Frise ailerons and split flaps, the latter extending from the body side to the inboard end of the aileron. Its construction consisted principally of two box type spars, the former also forming the leading edge, plus top and bottom connecting plates and rib formers connecting the spars together. Both flaps and ailerons were expected to be all-metal but, for ease of mass balancing, the latter could be fabric covered. The tail and fins were all-metal light alloy multi-cellular construction while the elevators and rudders would be fabric covered and fitted with trimming tabs.

The front turret carried two Browning machine guns, an amidships retractable turret housed two more while the tail defence consisted of Boulton Paul's patented 'Dumbbell' type mounting which housed two Brownings to either side (total four) with the gunner housed in the rear fuselage. This arrangement, which was produced as a mock-up, placed the guns in stub winglet fairings in an attempt to reduce the drag penalties of a completely moving turret, while also eliminating the need for a massive cylindrical mounting as previously used on Boulton Paul's Overstrand bomber.

Provision was made to carry 28 500lb (227kg) or 250lb (113kg) bombs on the manufacturer's own rotating magazine carriers. These were housed in the lower fuselage, two magazines followed by three followed by two, and were interchangeable with normal RAF bomb beams and other carriers that held seven 2,000lb (907kg) bombs. A total of 1,812gal (8,239lit) of fuel could be carried in six wing tanks, cruise speed at 15,000ft (4,572m) was 248mph (399km/h) and service ceiling 35,000ft (10,668m). An alternative scheme had four Napier Daggers with all-up-weight, fuel and performance all very similar to those of the Kestrel machine; the general layout was exactly similar except for changes to the engine installation.

Short Brothers S.29

No brochure is available for Shorts' original submission to B.12/36, principally because many of the company's papers and archives were lost during the war. However, the company's design office commenced work on the project in June 1936 and the design had four compartments placed either side of the spar frames to carry twenty bombs in four tiers of five.



Supermarine 316 as originally designed by R J Mitchell (29.9.36). Eric Morgan

Supermarine 316

This aircraft's single-spar wing made the tier storage of bombs unnecessary; instead they could be slung in a single layer in the fuselage and in the wing aft of the spar. Wing bomb storage also had the advantage of distributing the load over the span thus cutting down the wing bending moments in flight and thereby the weight of the wing itself. The single spar was near the maximum thickness of the wing, was made in light alloy and employed stressed skin covering. No fabric was used except on the control surfaces while the metal surface, with flush riveting, enabled not only a perfectly smooth surface to be established but one which was perfectly fair, something that was impossible when using fabric. Fuel tanks were incorporated in the wing structure as portions of the metal leading edge while the chassis used four wheels in pairs side-by-side to reduce the space needed for retraction (in its final form this project carried 2,500gal [11,367lit] of internal fuel).

The fuselage comprised an all-metal streamlined shell with a structure of main frames between the bomb bays and secondary frames in-between, all covered with Alclad sheet; the fuselage aft of the bombs became more truly monocoque. A single fin was chosen to help improve the range of the tail gunner's vision while the nose and tail turrets, with fixed transparent cupolas and the guns mounted underneath the gunner, were interchangeable and could accommodate two or four Brownings; there was also a retractable lower mid-turret. The tail was as clean as it was aerodynamically possible to make it while the rudder was long and narrow in order to reduce foot loads to a minimum. Both air and liquid-cooled engines could be used without alteration, except to the nacelles and cowling. The options were Bristol Hercules HE.1.SM or Pegasus XVIII, Rolls-Royce Merlin F or Kestrel KV.26, or Napier Dagger E.108, respective ceilings being 34,000ft (10,363m), 30,000ft (9,144m), 36,000ft (10,973m), 32,000ft (9,754m) and 32,000ft, and cruise at 15,000ft (4,572m) 300mph (483km/h), 258mph (415km/h), 275mph (442km/h), 258mph and 265mph (426km/h).

Vickers 293

This design employed geodetic construction (Duralumin with fabric covering throughout) and also offered a choice of engines – Bristol Taurus, Napier Dagger or Rolls Kestrel. The wing was elliptical and the undercarriage consisted of four separate units each retracting into an engine nacelle. All of the bombs were carried in the fuselage in superimposed layers (in an installation similar to the Wellington and Warwick) and all of the fuel (1,282gal [5,829lit]) was housed in the wings. The load comprised thirty 250lb (113kg) or 500lb (227kg) bombs, or 18 1,000lb (454kg) or seven 2,000lb (907kg) on special carriers. Respective service ceilings with these engines were 31,800ft (9,693m), 31,000ft (9,449m) and 33,000ft (10,058m), absolute ceilings 33,000ft, 32,300ft (9,845m) and 34,850ft (10,622m), maximum rate-of-climb 1,500ft/min (457m/min) up to 10,000ft (3,038m), 1,750ft/min (533m/min) at 5,000ft (1,524m) and 1,600ft/min (488m/min) at 15,000ft (4,572m) and cruise speeds at 15,000ft (4,572m) 245mph (394km/h), 233mph (375km/h) and 250mph (402km/h).

The standard Taurus had too much power and fuel consumption to be suitable for the specification so it was proposed to de-rate it by reducing the rpm from 3,225 to 2,975. The Taurus had been chosen ahead of the Bristol Perseus because of its extreme reliability in de-rated form and better performance; the Perseus gave not only a greater frontal area and fuel consumption but in fact hardly supplied enough power to meet B.12/36. There were three turrets, nose and amidships with two machine guns and the rear with four.

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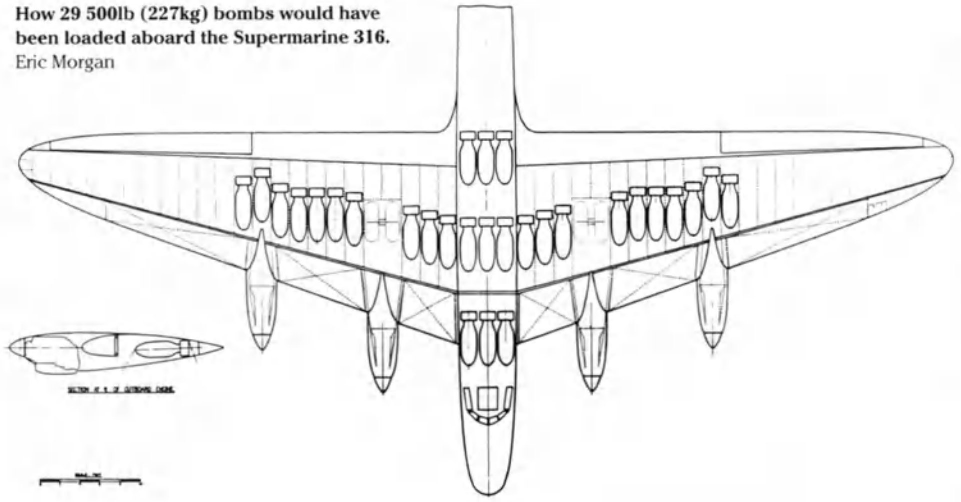
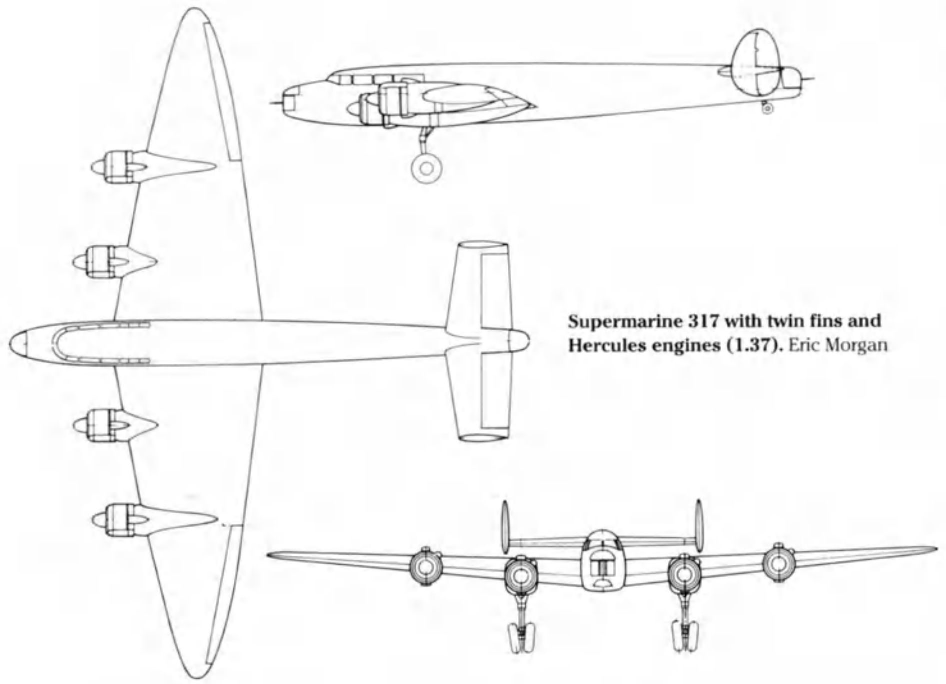
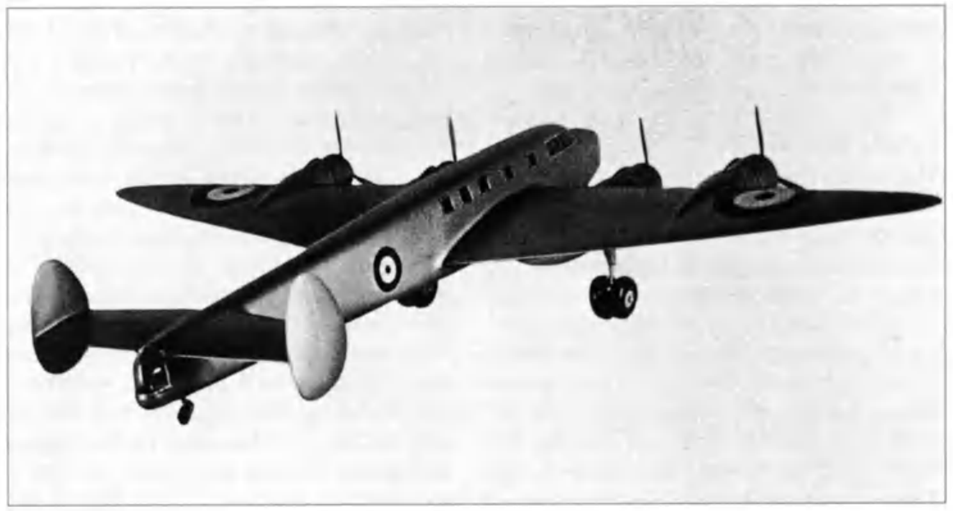
A Tender Design Conference was held in October 1936 and the order of merit put Vickers first followed by Boulton Paul, AWA, Supermarine and Short Brothers. Shorts' project was described as 'a robust effort but too near flying boat design'. In the event, no immediate decision was taken on prototypes and the discussions over each project's merits continued for another three months. DTD recommended that, if Vickers was held up by Wellington production, Boulton Paul's P.90 should be accepted which was ahead of the others in terms of easy manufacture. On 24th November, after an interview with Supermarine chief designer R J Mitchell, AMRD recommended quantity production of the 316 with the Hercules (but other engines should be capable of being fitted) with the P.90 as second string. DCAS agreed that the 316 was



How 29 500lb (227kg) bombs would have been loaded aboard the Supermarine 316. Eric Morgan



Supermarine 317 with twin fins and Hercules engines (1.37). Eric Morgan



Model of the Supermarine Type 317. Eric Morgan

the best in performance, construction, operational layout and armament details and added that he thought 'Supermarine should be relieved of other work to do the B.12/36'. CAS agreed but not to the point that the company should drop its cannon fighter, while the Supermarine factory was unsuitable for producing a bomber. As his second string, however, CAS preferred the Vickers 293 because Boulton Paul had not yet produced a satisfactory aircraft.

Finally, in January 1937, it was decided to order two prototypes of the Supermarine which, at the conference, was described as very attractive from the experimental point of view. However, in February CAS decided that another B.12/36 should be built as an insurance and he suggested that Shorts' should construct the alternative because the company had experience in building four-engined monoplanes (that is, flying boats). Shorts' S.29, however, had been adversely criticised at the design conference and so the company was asked to redesign it. The original Dagger installation would be acceptable but it was also desired that the Hercules should be considered as an alternative. Other suggested modifications included service ceiling raised to 28,000ft (8,534m) when carrying 2,000lb (907kg) bombs (as required by B.12/36), span reduced to 100ft (30.5m), the pilot to be moved further ahead of the airscrew discs and provision for a 'dustbin' type amidships turret; Shorts' representatives stated that these would require considerable redesign which would begin immediately. In April a further Tender Design Conference was held to assess both the improved S.29 and a new project submitted by Bristol.

Bristol B.12/36

This was powered by four Hercules 1,450hp (1,081kW) HE.3.SM engines which at 15,000ft (4,572m) offered a cruise speed of 290mph (467km/h). A total of 2,800gal (12,731lit) of fuel was housed in ten wing tanks and 28 250lb (113kg) or 500lb (227kg) bombs could be carried in six wing cells and in a long fuselage bay; seven 2,000lb (907kg) were an alternative load for the fuselage. The main gears had double wheels which protruded just a little after retraction. Just why this project was proposed so late is unclear.

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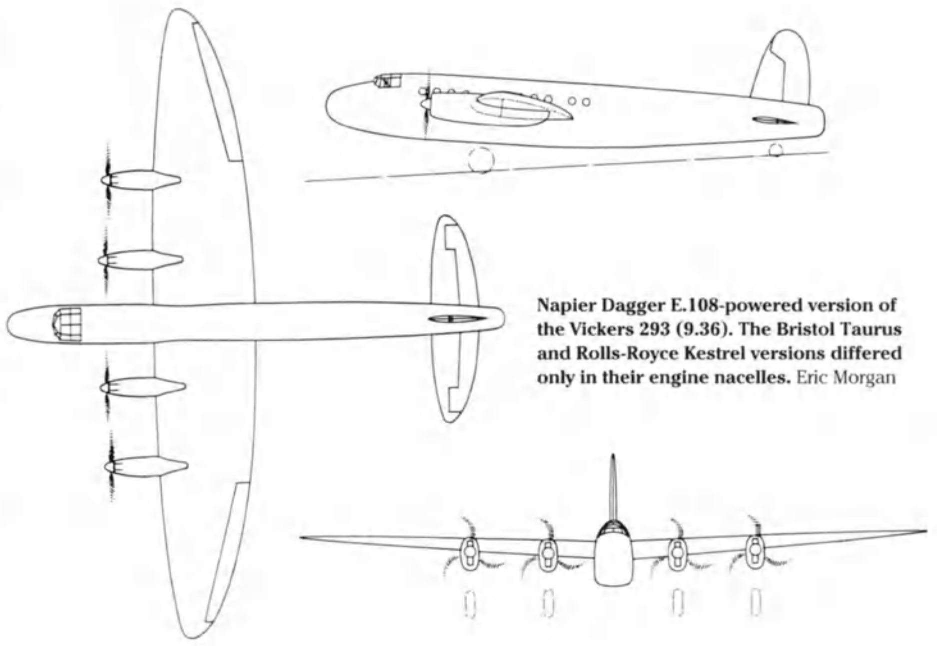
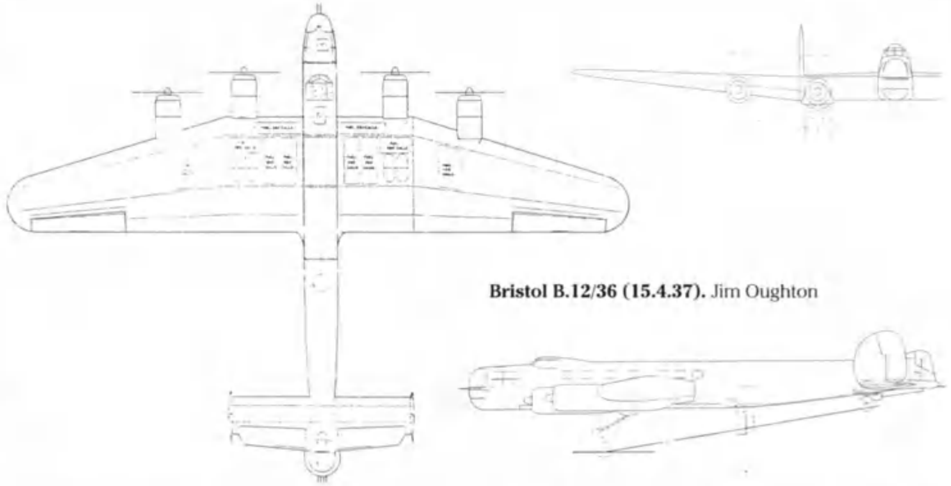
This second conference was unanimous that the modified S.29 would be the better of the two for the second string and in June the decision was taken to order two prototypes. When, on 21st July, the Air Ministry asked for Treasury sanction for prototypes of this second B.12/36 bomber it pointed out that, although the Supermarine bomber's programme was well planned, the death of Reginald Mitchell had introduced a certain degree risk into the production of the type. The Air Staff felt that B.12/36 was of outstanding importance and would become 'the main heavy bomber type in the near future'. America, France and Germany were all now building four-engine bomber types and so the production of the B.12/36 designs on a large scale was seen to be vitally important. Formal Treasury sanction for two S.29s was given on 6th October.

Supermarine's B.12/36 was reconsidered at a Design Conference held on 12th January 1937, particularly regarding the interchangeability of the Hercules and Merlin. In addition, to meet the landing requirements, the wing area was increased from 1,240ft² (115.3m²) to 1,358ft² (126.3m²) while further study of the tail unit had led to the adoption of twin fins and rudders; the revised project was numbered Type 317. Two prototypes of the 317 were ordered on 22nd March and on 24th May CAS described the bomber as 'a very fine design'. On 24th July CAS decided that Supermarine should give up working on the Merlin-engined variant (now numbered Type 318) and concentrate on the Hercules 317. On 12th August the mock-up was examined but the prototypes were never to be completed. A problem all along was the company's preoccupation with the Spitfire and then on 26th September 1940 the part complete fuselages were severely damaged during a bombing raid over the Itchen factory where they were being assembled; the Supermarine B.12/36 order was cancelled on 25th November.

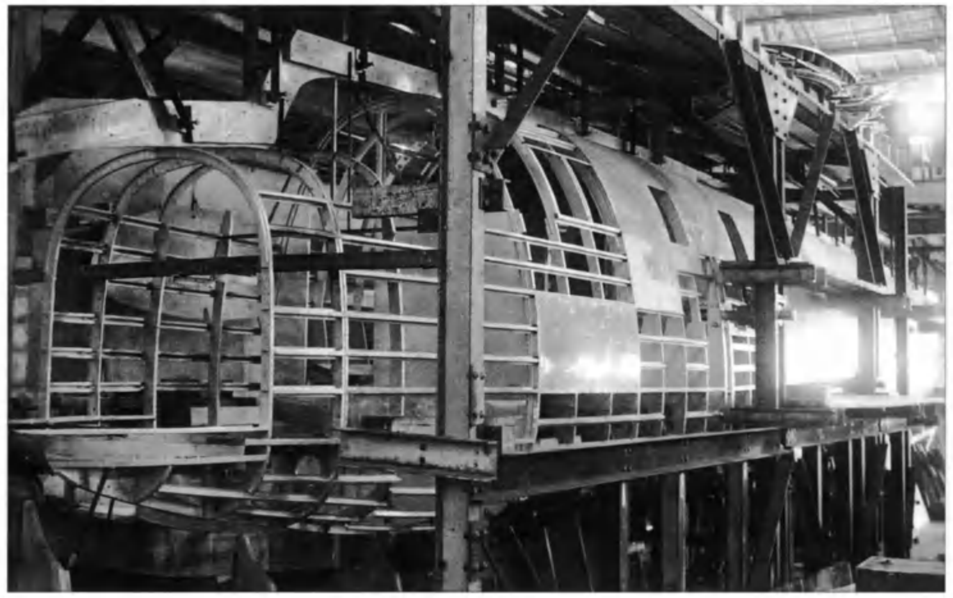
As a result the Stirling, as the S.29 was named, became the sole representative of the four-engined heavy bomber until the arrival of the Halifax and Lancaster described shortly. The final Stirling Mock-Up Conference was held in December 1937, the catapult take-off requirement was dropped the following April to cut down the structure weight and in November, after a recommendation from RAE, the tailplane was redesigned. Approximately six months late, the first prototype L7600 made its maiden flight on 14th May 1939 but crashed on landing, which meant that the full flight trials using



Napier Dagger E.108-powered version of the Vickers 293 (9.36). The Bristol Taurus and Rolls-Royce Kestrel versions differed only in their engine nacelles. Eric Morgan



Bristol B.12/36 (15.4.37). Jim Oughton



This view of the part assembled fuselage of the first Supermarine 317 prototype was taken in the spring of 1939. FlyPast

Shorts Stirling Mk.I N6065 seen on public display during or at the end of the war. The notice lists 14 bombing raids in which the aircraft had taken part. Short Bros.

the second machine L7605 could not be completed until August 1940.

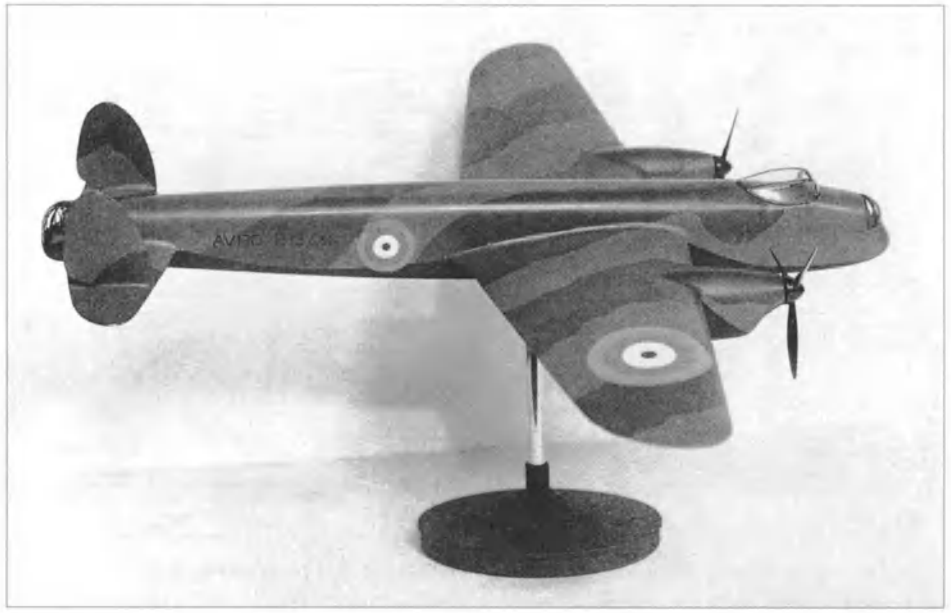
During the early stages of construction Shorts undertook to build a half-scale B.12/36 model called the S.31 which was powered by four small Pobjoy Niagara engines. DTD felt this would be 'of great value in proving the flying qualities and controls of the aeroplane to a much greater extent than wind tunnel experimental work'. The S.31 first flew on 19th September 1938 and the aerodynamic data that it generated brought some modifications to the full-sized Stirling, including the larger tailplane and increased flap area. The first 100 Stirlings were ordered in April 1938 but the performance of the first production machine fell some way short of B.12/36's requirements. However, it showed a heavy load carrying capability over short ranges which made it an ideal 'Ruhr Bomber', and for this operation the Air Staff was initially content with its performance. By the end of the war over 2,370 had been built and the type also served as a transport, paratroop carrier and glider tug.

(Author's Note: Many published sources have stated that the Stirling's span was limited to under 100ft (30.5m) by the size of RAF hangars; RAF and Air Staff policy is then usually criticised for contributing to the Stirling's poor ceiling and performance, but the 'hangar limit' is another false story. The largest RAF hangars actually had 120ft (36.6m) doors while B.12/36 requested 'good facilities for maintenance in the open'; in truth the 100ft limit was to prevent the aircraft from becoming too large while the key problem with the Stirling was its ever-increasing weight. It is suggested that the reader consults pages 168 to 170 of Colin Sinnott's book *The Royal Air Force and Aircraft Design 1923-1939* for a fuller description.)

Specification P.13/36 Avro Manchester, Avro Lancaster and Handley Page Halifax

The sister to B.12/36, P.13/36 requested a medium bomber but some Ministry documents also describe it, perhaps more accurately, as another heavy. With a maximum 8,000lb (3,629kg) load the range was to be at least 2,000 miles (3,218km) while at lower weights this was to be 3,000 miles (4,827km). The highest possible cruising speed was desired to keep the period spent over enemy territory to a minimum, and at 15,000ft (4,572m) this had to be at least 275mph (442km/h). All-round defence was essential with nose and tail turrets, the forward housing two machine guns with four in the rear. The bomb load was sixteen 250lb (113kg) or 500lb (227kg) or four 2,000lb (907kg) and some aircraft also had to be able to carry two 18in (45.7cm) torpedoes; the maximum load would require a catapult take-off. This aircraft was expected to be approximately the same weight as the B.1/35 Warwick but would be a good deal smaller and faster. P.13/36 was issued for tender on 5th November 1936 to Avro, Boulton Paul, Bristol, Fairey, Handley Page, Hawker, Shorts and Vickers; only Vickers declined but the company did put together a design based on the Warwick.

Well known view of Stirling Mk.III BF509. Short Bros.



Model of the original Avro 679. Avro Heritage Centre

Avro 679

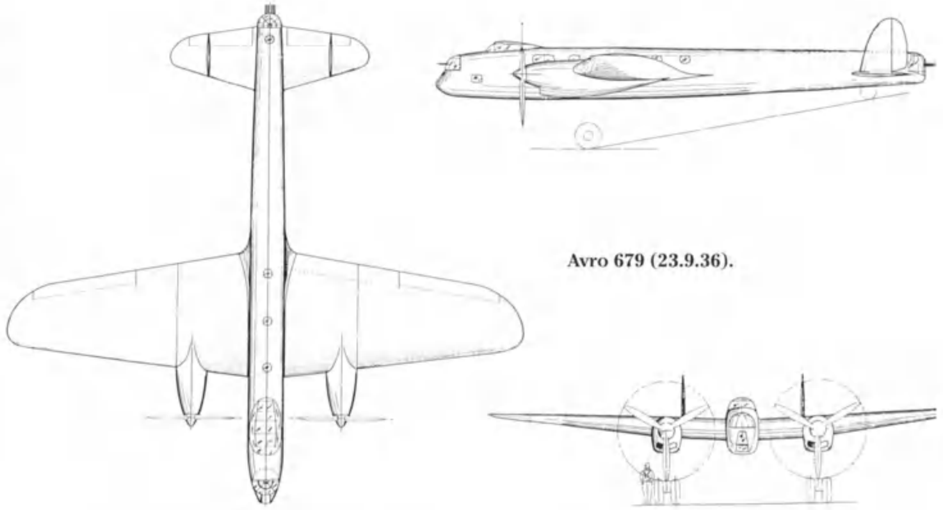
Avro's original Type 679 was quite different from the eventual Manchester, work having begun in September 1936 well before tender. It had two Vultures, twin fins and two side-by-side wheels on each main gear, plus the bow and stern turrets (the dorsal turret came later). Three alternative catapulting schemes were suggested and the internal fuel totalled 1,600gal (7,275lit).

Boulton Paul P.91

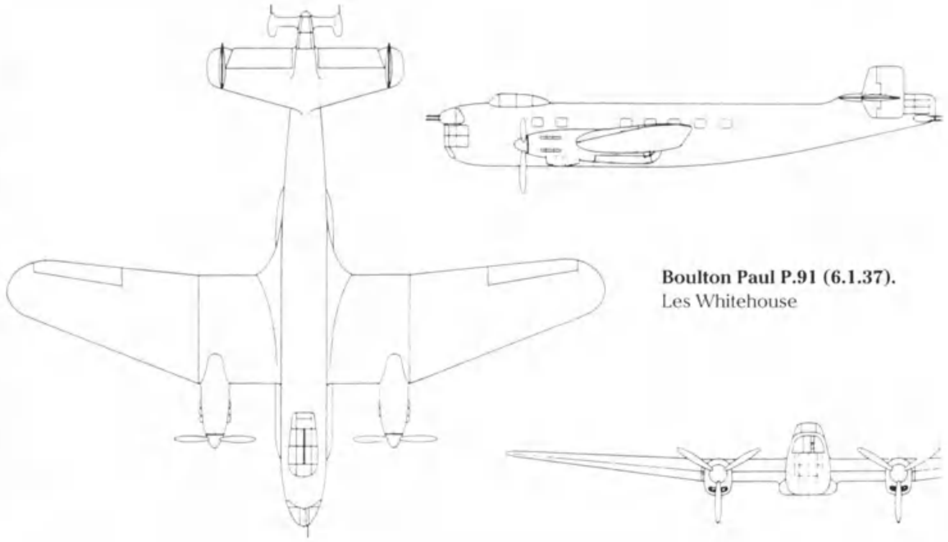
This aircraft used the same layout as the P.90 to B.12/36 and the same turret and rotating bomb bay arrangement, but it also offered as an alternative a much lower bay for normal bombs, though this was still wider than the rest of the fuselage. The P.91 also employed two Vultures which gave an estimated maximum rate of climb of 2,240ft/min (683m/min) at 15,000ft (4,572m), cruise at that height of 277mph (446km/h) and service ceiling 38,000ft (11,582m).

Bristol P.13/36

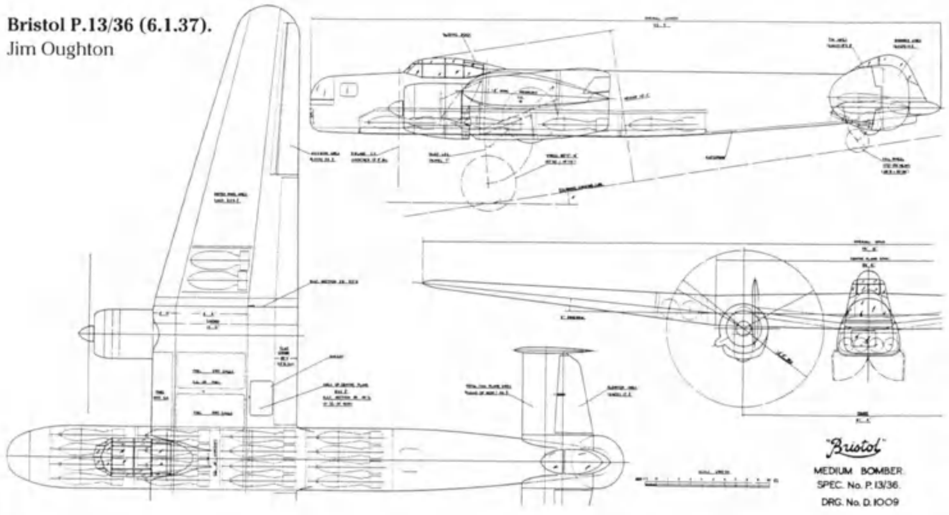
This design followed normal Bristol practice. Its wings had two spars with all-metal Duralumin covering and the body employed continuous extruded stringers through notched formers, again metal covered. Considerable use was made of components from previous Bristol designs (Blenheim and Types 149 and 152), such as controls, seating, engine parts, etc, where the drawings and jigs were available. The designers noted that the size of this type of aircraft when fitted with Hercules radials was such that the wing was too small to accommodate the large bomb load. Therefore all of the sixteen smaller bombs were carried in one tier within the body in four groups of four; the four 2,000lb (907kg) bombs were, however, housed in pairs in each wing just outboard of the nacelles. All of the fuel (1,320gal [6,002lit]) was housed in the centre plane and the rear defence comprised the four 0.303in (7.7mm) machine



Avro 679 (23.9.36).



Boulton Paul P.91 (6.1.37).
Les Whitehouse



Bristol P.13/36 (6.1.37). Jim Oughton

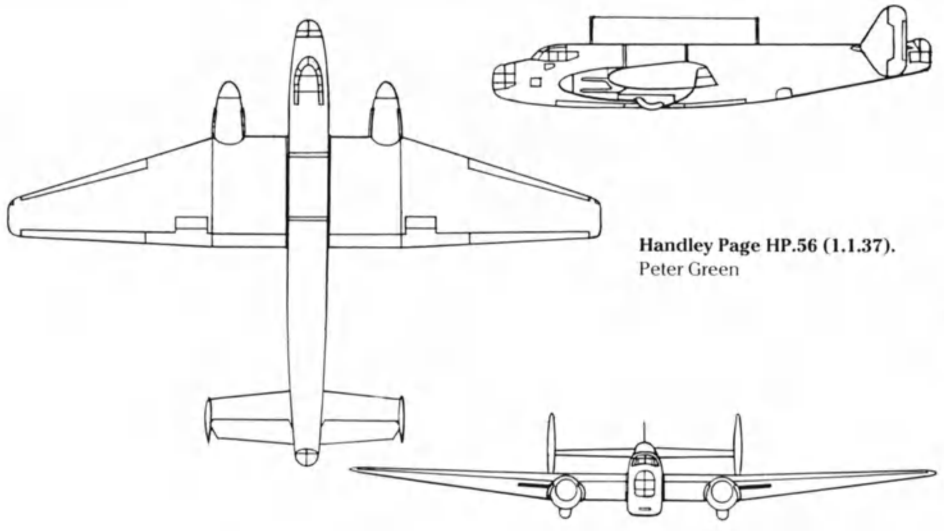
guns housed in a fairing underneath the gunner, who aimed with a mechanically-operated sight. Estimated maximum cruise speed was 261mph (420km/h), rate of climb 2,600ft/min (792m/min) at sea level, service ceiling 36,600ft (11,156m) and absolute ceiling 37,600ft (11,460m).

Fairey P.13/36

Powered by two of Fairey's own P.24 engines with radiators in the wing centre section leading edge (Vultures or Sabres were alternatives), this streamlined design was an all-metal structure based on the P.4/34 light bomber and fabric-covered control surfaces. Bombs were carried in eight enclosed cells in the fuselage and six in the centre section; the former could be replaced by torpedo carriers. The nose turret had two 0.303in (7.7mm) Brownings and the tail turret four more; for improved streamlining the latter could be removed and replaced by retractable dorsal and ventral turrets aft of the bomb cells. Estimated time to 25,000ft (7,620m) was 13 minutes and service ceiling 34,500ft (10,516m).

Handley Page HP.56

This was to be powered by two Rolls-Royce Vultures, but chief designer George Volkert also assessed an alternative installation with a new 2,000hp (1,491kW) engine proposed by Napier (which later became the Sabre). The HP.56 had twin fins, large main wheels and a two-spar wing which employed a combination of corrugated and flat sheet covering in the most highly stressed areas; this was a break from normal Handley Page practice and the wing also contained all of the fuel (1,650gal [7,502lit]) in cells built integral to it. The monocoque fuselage, flaps, ailerons and tail assembly followed more recent Handley Page practice.



Handley Page HP.56 (1.1.37). Peter Green

Hawker P.13/36

Another design to use twin fins and two Vultures, this carried 1,820gal (8,275lit) of fuel in tanks placed in the inner wings between the nacelles and body.

Shorts P.13/36

No drawing of this project is known to exist but a photograph of the company's display model has come to light. It shows a design with twin Vultures that looks similar to the other P.13/36 projects but, apart from the untendered Vickers, appears to be the only one to employ a single large fin.

Vickers P.13/36

This project was derived from the B.1/35 Warwick and was powered by two Vultures. Span was about 97ft (29.6m) and length 72ft (21.9m). It was not tendered.

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The Tender Design Conference was held on 10th February 1937 and Avro's 679 was placed first with Handley Page second. The HP.56 was chosen as the second string to Avro's project and DTD recommended that two prototypes of each should be ordered. Ordering duplicate prototypes had only recently become an accepted principle because it helped to reduce the development period; hitherto this had been considered too expensive but the urgency generated by the prospect of war had drastically altered the situation. Avro and Handley Page received their formal prototype contracts in April.

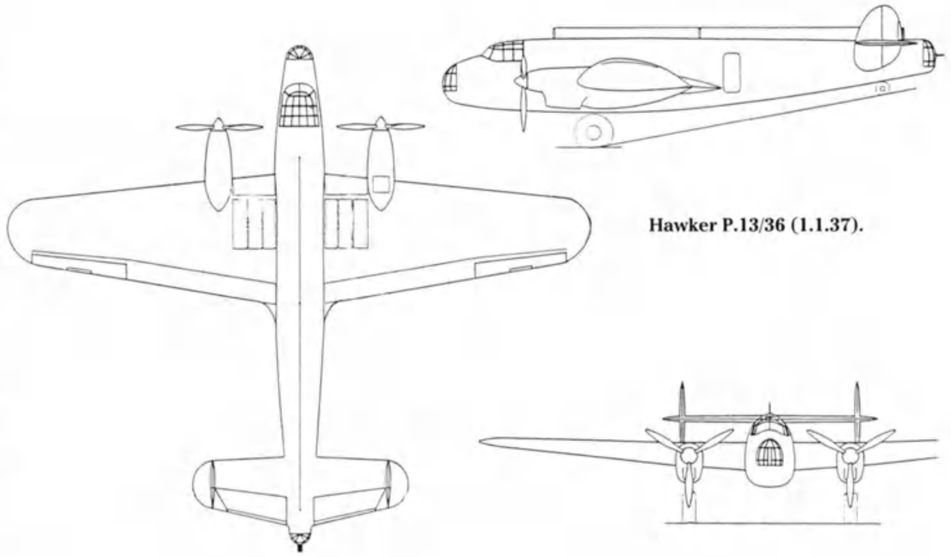
Avro 679 Manchester

The Air Ministry was anxious that the 679's development should proceed as quickly as possible and on 1st July 1937 a production order was placed 'off the drawing board'. At this time the job of enlarging the RAF in readiness for war (the expansion programme) was in full swing and the Air Staff could not afford to wait, as previously, up to six years for a new aircraft to reach production. In 1935 the government granted permission to put a new type into production direct from the contractor's drawings and the Air Staff proceeded to use this discretion to the full. Both Avro's and Handley Page's designs had been analysed by DTD's department and it was their promise in the role of the RAF's new striking force that saw both ordered 'off the board'. In March 1937 it was decided that all medium bombers not delivered by 1st April 1939 should be replaced by P.13/36 types, preferably the Avro 679 but alternatively the HP.56, and the Chancellor of the Exchequer approved this scheme in April 1937.

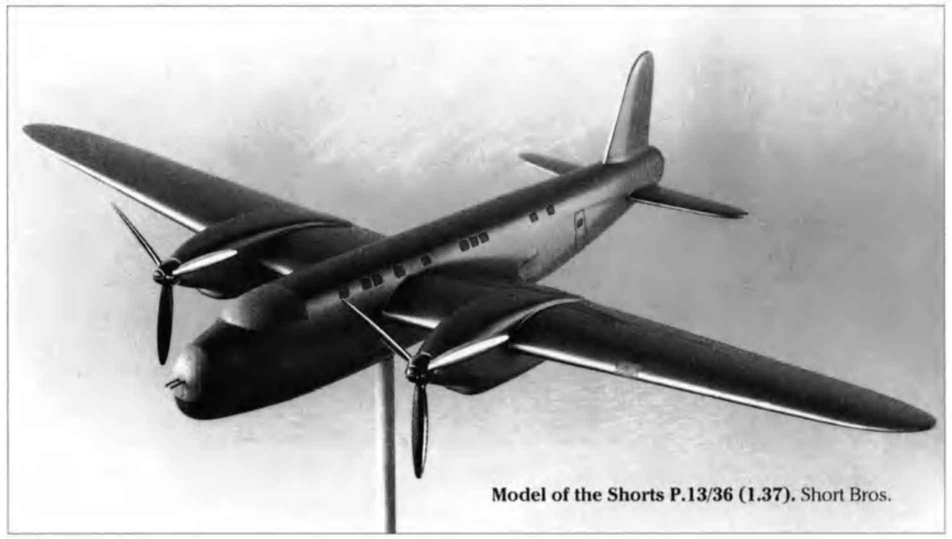
The Mock-Up Conference was held on 4th May (two mock-up noses had to be scrapped before final approval was given) and on 4th August it was decided that the first prototype should be fitted with Hercules engines and the second with the Vulture (in the end no Manchester ever used the Hercules). Over the next year the torpedo and catapult launch requirements were dropped and the first prototype L7246, now called Manchester, flew on 25th July 1939. The cumulative effect of these changes retarded the prototype's progress, particularly dropping the catapult in July 1938 when the structures for the first batch had been completed with the required fittings in place. These added weight but would be expensive to remove (£50,000 was quoted for new jigging), while such a step would also bring more delay.

Flight trials revealed that the Manchester exhibited poor take-off performance, especially at 40,000lb (18,144kg) weight, and was directionally extremely unstable; the second problem was solved by fitting a third central fin but weight was always an issue. During development both the fixed and military load rose considerably so that when the aircraft's weight was finalised it was found to be much heavier than expected. In May 1940 DGRD reported to AMDP that, since February 1939, the equipped weight had risen by 4,485lb (2,034kg) and a further 550lb (249kg) was about to be added. An unassisted take-off at more than 45,000lb (20,412kg) was not assured and the increases in equipment meant that the bomb load was being reduced to a negligible figure. Measures proposed by Avro to lighten the structure included reducing the thickness of the covering skin, wooden bomb doors, increasing the span from 80ft to 90ft (24.4m to 27.4m) and other changes in design and equipment, which gave a net saving of 1,550lb (703kg); even so Avro was forced to restress the aircraft six times. The new wingtips were fitted to the prototypes in July 1940 and successful take-offs at 45,000lb were achieved, but the maximum fuel and bomb loads could still not be carried together.

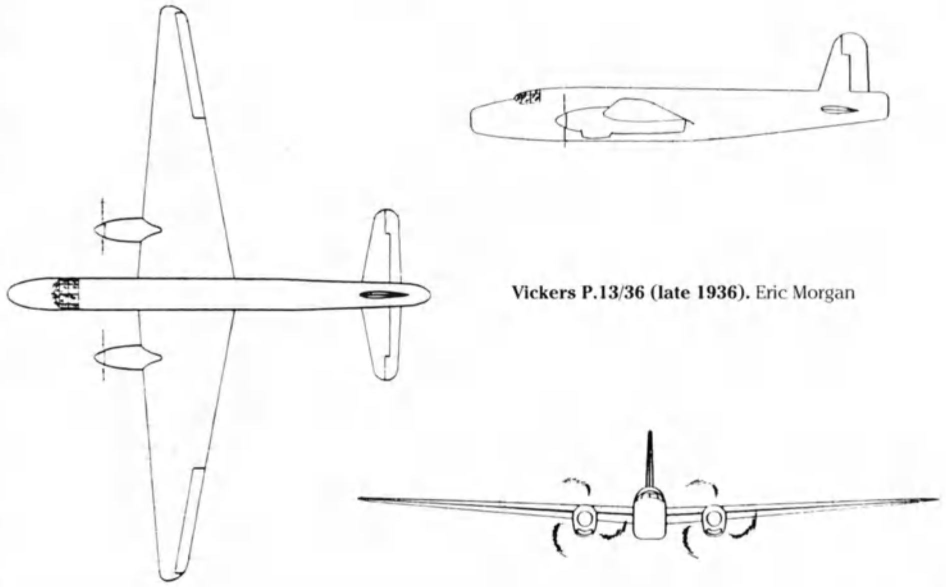
This situation was compounded by development problems with the Vulture (failures were frequent and the type struggled to maintain height on one engine – there were numerous forced landings). In 1940 Rolls-Royce abandoned the engine and this decision, together with the technical position of the Manchester itself, meant that the future of the type was extremely uncertain, just at the point when production was about to get going. Production of the Manchester gradually faded out until it ceased altogether in 1941 after just 200 had been built. There were



Hawker P.13/36 (1.1.37).



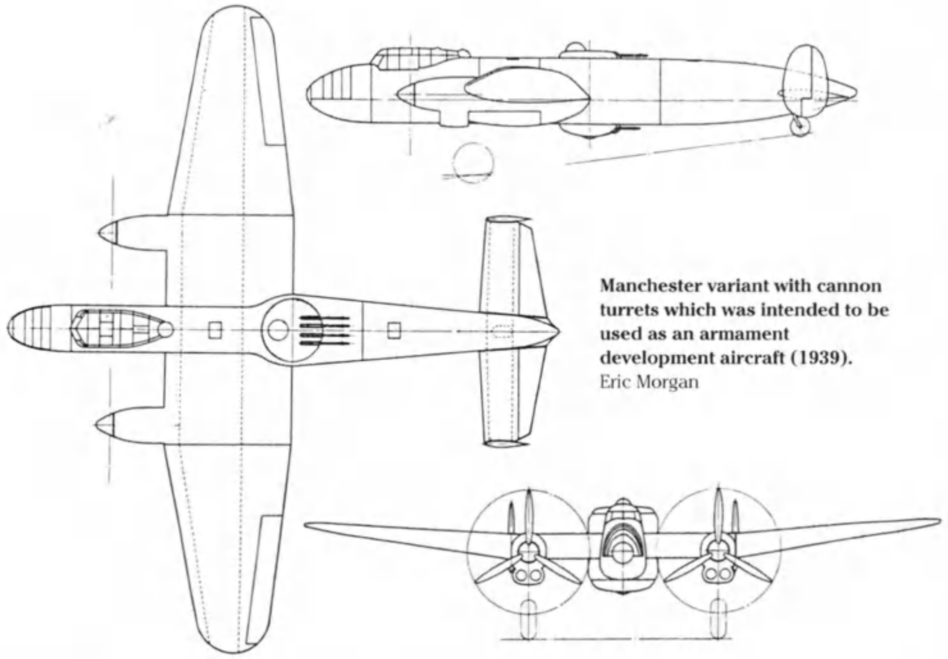
Model of the Shorts P.13/36 (1.37). Short Bros.



Vickers P.13/36 (late 1936). Eric Morgan

The second Avro Manchester prototype L7247. The third central fin is just visible. Peter Green

The Manchester Mk.1A dispensed with the central fin and introduced larger tip fins. The aircraft is unidentified but may be L7486.



Manchester variant with cannon turrets which was intended to be used as an armament development aircraft (1939). Eric Morgan

proposals for alternative engines – a twin Centaurus arrangement was drawn in 1938 and there were plans to fit the Napier Sabre. The redesign of the Manchester to take four Merlin engines as the Lancaster is described shortly.

There was also a more radical Manchester development that had a dorsal and ventral double turret with four cannon in each and the nose and stern turrets faired over. In 1939 contracts were apparently placed with Shorts, Handley Page and Avro for versions of the Stirling, Halifax and Manchester fitted with cannon turrets, the three prototypes being R2659, R2665 and R2671. As the drawing shows, the Manchester redesign was quite extensive. The four 20mm turret was quite popular during the late 1930s being earmarked for the B.1/39 bomber (below) and the Boulton Paul P.92 fighter (Chapter 3), but none of these designs ever flew.

Handley Page HP.57 Halifax

The HP.56 Mock-up Conference was held on 8th July 1937 and the serials allocated to the prototypes were L7244 and L7245. However, on 24th July CAS decided that the aircraft should be refitted with four engines. The new Vulture was already suffering from various technical difficulties, it was not going to give enough power and the Air Ministry was anxious not to have to rely on it too much. Its eventual failure was ultimately responsible for the redesign of both the Manchester and the HP.56, but the latter was modified well before first flight.

The Air Staff's discussions leading to the change in the type's powerplant were all-embracing but a choice of four Merlins was eventually made ahead of a twin Hercules installation since the Merlin was the only engine likely to be available in sufficient numbers. A version showing four Bristol Taurus radials had also been requested by Air Marshal Freeman on 19th July 1937. The Merlin produced less power than the Vulture, which meant four units were needed instead of two and, at first, Volkert was very unwilling to alter his project because the wings would have to be completely redesigned to take two units each. At that time a wing mounting two engines was highly experimental and had to be submitted for stringent strength tests at RAE, while the weight of the wing and the whole aeroplane rose by a large margin which necessitated the strengthening of the structural members. The span was increased from 88ft to 99ft (26.8m to 30.2m) and the weight went up from 39,000lb (17,690kg) to 52,000lb (23,587kg).

Work on the HP.56 was abandoned on 18th August and the design effort was switched to the new four engine HP.57, which was essentially a new aircraft. Volkert admitted that the change was a terrible blow but he very quickly realised the advantages that were going to accrue. On 3rd September Handley Page was officially notified of the decision to switch to four Merlins and the work eventually delayed the prototype by about six months. However, the catapult requirement could now be deleted since enough power was available for a take-off at maximum overload, albeit with a long take-off run; the torpedo requirement was also dropped in July 1937. A revised Mock-up Conference was held in December, the hand-building of both prototypes began in March 1938 and by July most of the design work was complete with construction of the fuselage and other items of equipment well under way.

The prototype made its maiden flight on 25th October 1939. When the Avro Manchester became the first P.13/36 bomber to be chosen for production it was considered to show the greater promise. However, after Handley Page's project had been redesigned with four engines, it assumed a much greater importance in the Air Ministry's re-equipment plans. The first production order was placed on 7th January 1938 and these aeroplanes were to use the serials originally allocated to production HP.56s. Soon afterwards the type received its official name, Halifax, and it was to serve throughout the war in many roles. Later, following complaints made at the highest level about the aircraft's poor performance, it was re-engined with four Hercules – despite being perhaps the most successful of all British piston engines, the Merlin never really suited Handley Page's bomber. Over 6,170 examples of the Halifax were produced.

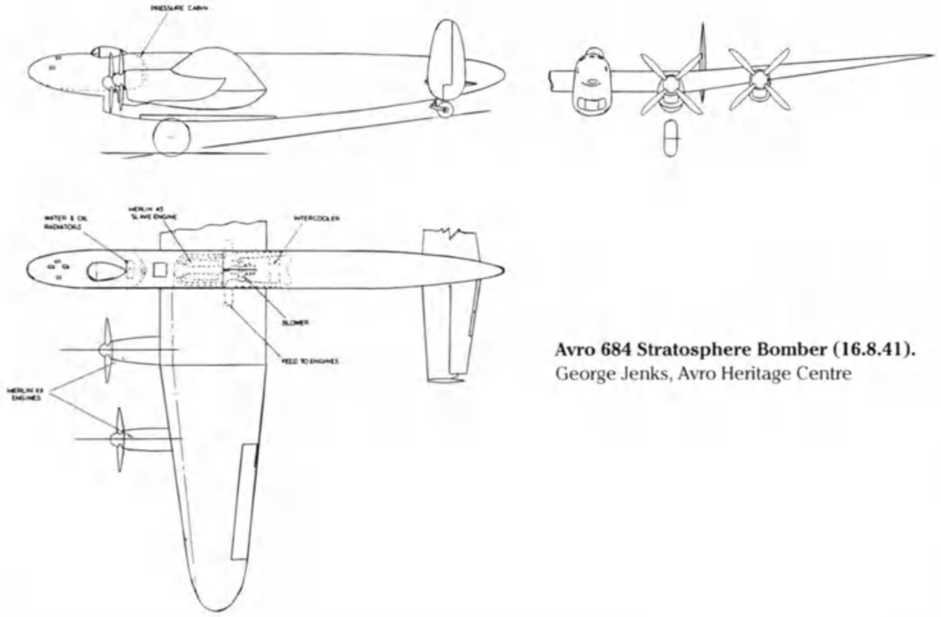
Handley Page Halifax Mk.IIB W7676 of No 35 Squadron with Merlin powerplants.

Halifax L9520 was the first example of the type to be fitted with Dowty landing gear and is seen at Staverton in mid-1942. Peter Hall, Messier-Dowty

RT894 was a Hercules-powered Halifax A Mk.IX used for towing the Hamilcar glider and is seen landing on 10th January 1950. BAE Systems Brough Heritage Centre

This picture of Lancaster Mk.I R5689 was taken in mid-1942 when the aircraft was serving with No 50 Squadron. It was destroyed by fire on 19th September 1942.

An AWA view of DS771, one of the few Lancasters built with Hercules powerplants. Ray Williams



Avro 684 Stratosphere Bomber (16.8.41).
George Jenks, Avro Heritage Centre

Avro 683 Lancaster

As early as April 1937, before the HP.56 was modified with four engines, Roy Chadwick, chief designer at Avro, was giving thought to fitting four Hercules onto the Manchester. Sir Wilfrid Freeman (AMDP) also mentioned such a scheme and the first drawings were produced in 1939. Thus, when the Manchester's future came into question Avro had proposals ready to covert it into a four-engined aircraft. However, during August and September 1940 there was caution over the project – was this the correct step to take because the Halifax was currently the most favoured heavy bomber (and was to be used throughout as a yardstick)?

Initially Avro's project received no enthusiasm from MAP who thought that the Manchester was incapable of further development and felt that the company's optimistic promises were ill-founded. The main argument for proceeding was that, because the Manchester's jigs and tooling could be used, it was the best way to produce the greatest number of aircraft in a given time. Freeman supported Avro throughout the whole controversy and persuaded the Minister of Aircraft Production, Lord Beaverbrook, to give the company his permission to go ahead. A contract for one prototype, BT308 (a Manchester removed from the production line and rebuilt), was placed in September 1940. Patrick Hennessey however, who under Beaverbrook had much influence over the choice of new projects, was not helpful and even went so far as to refuse Avro the raw materials needed for the prototype's construction. Avro's Managing Director remembered Hennessey's final reply was 'to go and dig for it' (later Hennessey became more favourably inclined towards the aircraft).

Fortunately for Avro the distribution system for light alloys was imperfect and the company was able to obtain enough materials to build the aircraft; work on BT308 began in August 1940. By late November the controversy was virtually over and the new type, named Lancaster on 29th October, was allowed to go ahead. This result was achieved through the initiative and perseverance of Avro and in spite of MAP, who only half-heartedly admitted that it might achieve a performance as good as the Halifax. By the end of the year, however, the design was showing sufficient promise for enough support to be gained within MAP to permit a sizeable order to be placed. The prototype, which first flew on 9th January 1941, was not built to a formal specification but the Air Ministry did formulate an Operational Requirement.

The initial proposals had only envisaged switching the engines and stretching the span to 100ft (30.5m) but Ministry requests for an operating weight of 57,000lb (25,855kg) eventually made it necessary to redesign the wing and most of the undercarriage. Nevertheless Chadwick described the differences in structure between the Manchester and Lancaster as 'small'. The production programme was accelerated and the Lancaster eventually became the premier aircraft, both in numbers and performance, in the British bomber offensive against Germany. Over 7,370 were built and a small number (300) were powered by Hercules engines as an insurance against a possible shortage of Merlins (a situation which never came about). In July 1941 Avro suggested a high-altitude Lancaster which had Merlin 60s and a nose similar to the Vickers high-altitude Wellington; a year or so later it drew a high-speed version with streamlined nose, engine nacelles and rear fuselage, no nose turret and 0.5in (12.7mm) machine guns in dorsal and rear turrets.

Avro 684

In August 1941 Avro completed a brochure for its Type 684 Stratosphere Bomber. This all-metal aeroplane was designed to operate at a height that made it immune from fighter or anti-aircraft interference and, with the exception of the nose portion of the fuselage, was identical to the Lancaster. The nose contained a pressure cabin, as designed for the experimental high-altitude Vickers Wellington flown in September 1940, which, in conjunction with a Rotol blower, would maintain air conditions corresponding to 10,000ft (3,048m) when flying at an altitude of 40,000ft (12,192m). To achieve this high-altitude flight the air flowing to the carburettors of the four wing-mounted Merlins would be increased in pressure by a 'slave' Merlin 45 housed within the fuselage between and above the wing spars (the blower was placed behind the rear spar). By regulating the rpm of the slave blower to suit the prevailing conditions its discharge pressure could be made to correspond to 20,000ft (6,096m) conditions at all heights between 20,000ft and 40,000ft (12,192m).

The 684 could carry either 4,000lb (1,814kg), 8,000lb (3,629kg) or 12,000lb (5,443kg) bombs, average cruise would be about 320mph (515km/h) and range 2,300 miles (3,701km). The service ceiling at the start of a mission (60,000lb [27,216kg] weight) was 42,000ft (12,802m) and at the end of a flight (at 38,492lb [17,460kg]) 49,600ft (15,118m). The absolute ceiling at the latter weight was 50,300ft (15,331m), sea level rate of climb at 60,000lb was 940ft/min (287m/min) and at 38,492lb 1,910ft/min (582m/min), time to 40,000ft (12,192m) was 57 minutes. A total of 2,130gal (9,685lit) of fuel were carried in the wings. The development workload needed for the standard Lancaster and its variants, and the new Avro 685 York transport which used the same mainplane, power eggs, tail and undercarriage, led to design work on the 684 being suspended.

Specification B1/39 The Ideal Bomber

Despite the arguments for and against defensive armament, by 1938 the Air Ministry was fearful of the performance and armament of Germany's latest fighters and so the heavy bomber's protection had to be improved. Countering the fighter's machine guns or cannon would need up to six machine guns in turrets firing backwards and downwards but this alone would be insufficient, protective armour was also needed. In 1937 and 1938 experiments were made with thin sheets of armour plate and bullet-proof glass but there was a limit because of their effects on the aircraft's CofG. Self-sealing petrol tanks would also soon be available but, although good, they were twice as heavy as ordinary tanks. A good ceiling would help to avoid flak but this brought with it extra equipment such as oxygen and heating for both crew and guns (Browning machine guns froze at -10°C, the summer equivalent of 15,000ft [4,572m]). Each of these steps made a bomber larger, heavier and more complex.

In March 1938, partly from work done by the 'Bombing Committee' during 1937 and 1938, a paper was produced that detailed an Ideal Bomber for the RAF. It suggested an 'optimum size' standard type for all squadrons both at home and overseas and five sizes were considered from Type A (18,000lb [8,165kg] gross weight, 58ft [17.7m] span, 4,000lb [1,814kg] bomb load) to Type E (160,000lb [72,576kg], 172ft [52.4m], 44,000lb [19,958kg]), which was the largest possible aircraft capable of being developed within six or seven years. The Ideal Bomber had to have a defensive armament 'capable of developing a volume of fire sufficient to engage the maximum number of fighters which can attack simultaneously' while both experimentation and Spanish Civil War experience had revealed that 'the modern high-performance fixed-gun fighter can only operate successfully in the astern attack'; therefore the bomber would need a four-gun tail turret.

After considerable further study the Air Staff recommended that Type B (35,000lb [15,876kg], 80ft [24.4m], 8,000lb [3,629kg]) should be produced and the outcome was specification B.19/38 of mid-1938 which called for eight 20mm cannon mounted in two turrets amidships, one above and one below the fuselage, to give protection above, below and to the rear (it was considered that 0.303in [7.7mm] machine gun fire would be largely useless by the time the B.19/38 took to the air). By September it was clear that the aircraft would be substantially larger than first thought and on 28th December B.19/38 became B.1/39. This document requested a 280mph (451km/h) cruise and 2,500 miles (4,023km) minimum range at 15,000ft (4,572m) with 9,000lb bombs (4,082kg), four engines and a maximum weight of 50,000lb (22,680kg).

In January 1939 it was decided to invite industry to tender. Despite the decision to concentrate on the Halifax as the standard production bomber for the striking force, it was agreed in April that this in no way lessened the need to press on with advances in design. Sholto Douglas, ACAS, felt that the B.1/39's development should proceed on the highest priority and he declared that he would be prepared, if necessary, to visit the Treasury to explain the Air Staff point of view on the matter.

Meanwhile Boulton Paul, as part of the development work for its P.92 fighter (Chapter 3), had successfully demonstrated the mounting and firing of a single 20mm Hispano cannon in a powered turret. This company had also developed a method for installing circular low profile multi-cannon turrets with a high degree of aerodynamic efficiency, where the loss in speed compared to an unarmed version was just 5%. It appears that industry was given sufficient information about this for tendering, with an agreement that the successful firm would then be supplied with all of the available information. Frazer-Nash developed a rival turret and it was acknowledged that the weight of such mountings would reduce the bomb load by 4,000lb (1,814kg). The response from industry to B.1/39 was substantial but information on the following projects is relatively sparse.

Armstrong Whitworth AW.48

A design which used semi-monocoque construction and AWA's usual conventional box-spar wing. The extensive fairing of the wings and fuselage made blending the two Boulton Paul turrets relatively simple, while a new feature was a long-travel undercarriage which gave the AW.48 the ability to fly directly onto a runway without a round-out before landing. A good deal of experimentation was made on this new landing gear which included sliding a model down a cable to demonstrate the approach angle and the response of the wheels on touching the ground. The AW.48 could carry nine 500lb (227kg) bombs internally and twelve more in underwing cells, giving a full load of 10,500lb (4,763kg) which was 1,500lb (680kg) over B.1/39's stated load. Internal fuel totalled 2,300gal (10,458lit), cruise speed was 302mph (486km/h) at 15,000ft (4,572m) and service ceiling 26,000ft (7,925m).

Avro 680

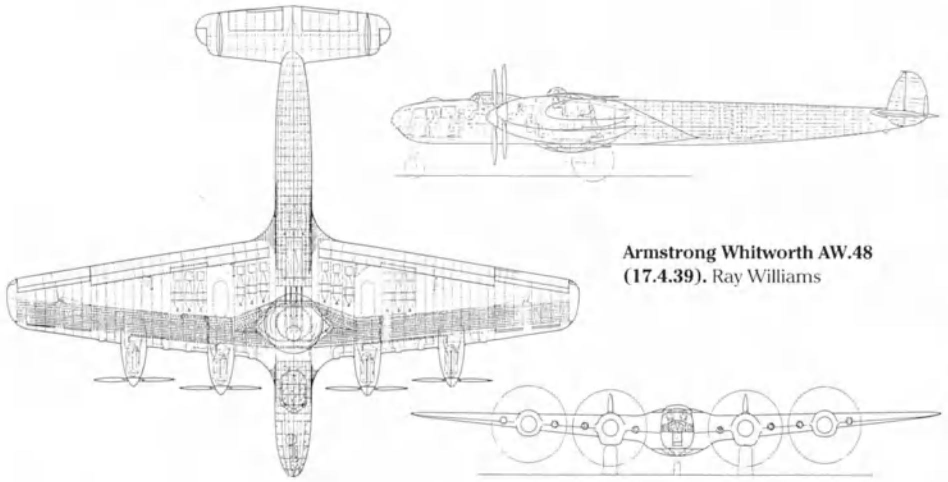
Avro's project used a conventional two-spar stressed-skin wing which, together with the tail, had plenty in common with the Manchester (although the brochure did not supply much detail). The two Frazer-Nash turrets projected outside the lines of the fuselage while four Hercules or Griffon, or a combination of two Vulture and two Merlins, would form the powerplant. The cruise speed at 15,000ft (4,572m) with the Hercules was estimated to be 280mph (451km/h), with Vulture/Merlins this became 271mph (436km/h), and the service ceiling with the Hercules was 26,200ft (7,986m).

Blackburn B.30

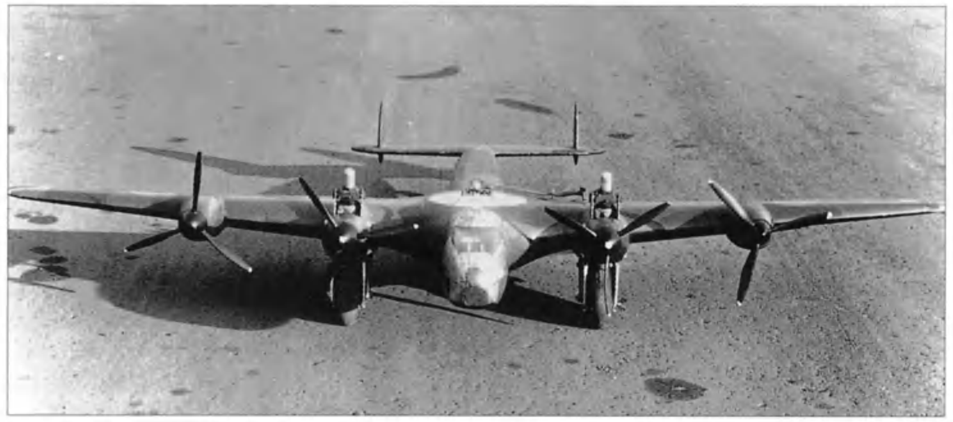
A design which had its two-spar stressed skin wings faired into the fuselage to assist the installation of either Boulton Paul or Frazer-Nash turrets. The engine choice was four Griffons, standard Hercules or ducted radiator-cooled Hercules which offered a respective cruise at 15,000ft of 272mph (438km/h), 261mph (420km/h) or 265mph (426km/h). Internal fuel was 2,650gal (12,049lit) and service ceiling (Griffon) 24,000ft (7,315m).

Bristol 159

Except for a single bomb cell placed outside each outer engine this project carried all of its bombs, 15,000lb (6,804kg) maximum, in the inner wing and fuselage between the spars (in fact most of the B.1/39s had their bombs in the wings to enable the heavy turrets to be placed near the CofG). The fuel tanks, which held 2,580gal (11,731lit), were placed between the engines. The 159 used orthodox wing construction while its small diameter streamlined Bristol designed turrets, projecting from the fuselage, were housed mid-fuselage in an armoured monocoque structure. This was the only low-wing B.1/39 project and Bristol favoured the Hercules engine, although Griffons could also be installed. It would cruise at 282mph (454km/h) at 15,000ft (4,572m) and its service ceiling with the Hercules was 25,300ft (7,711m) and with the Griffon 23,700ft (7,224m).



Armstrong Whitworth AW.48 (17.4.39). Ray Williams



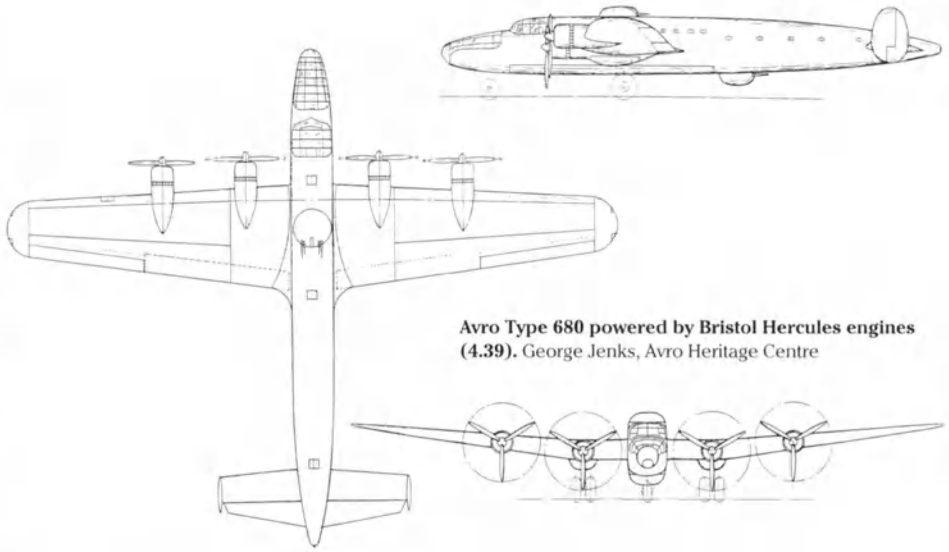
Model of the AW.48. The fittings above the inner engines are probably for sliding the model down a cable to assess the AW.48's landing characteristics. This model actually features a tail-wheel undercarriage which was not part of the design as tendered. Ray Williams

Fairey B.1/39

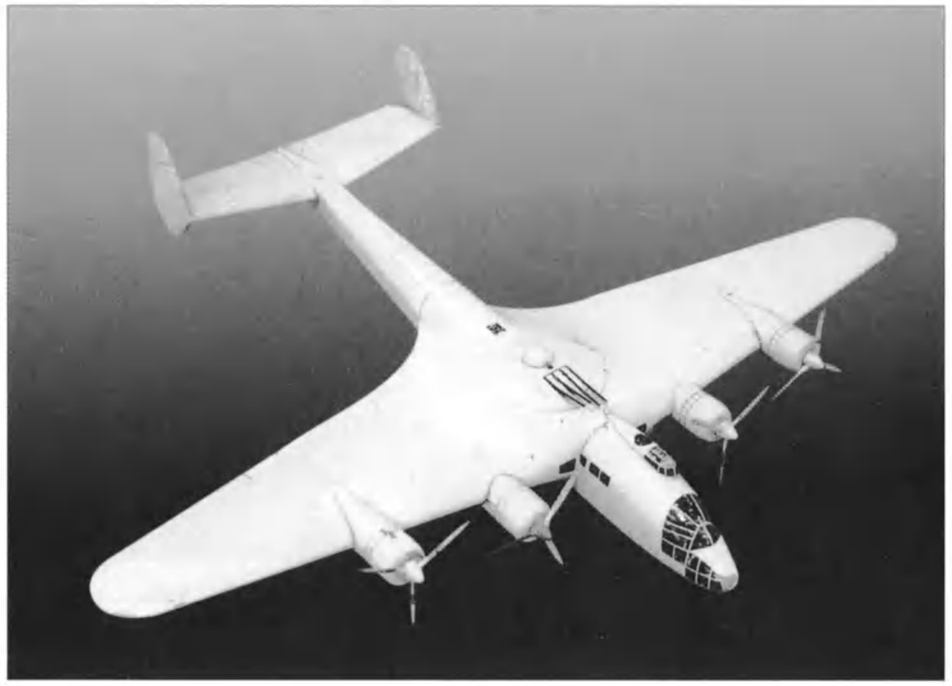
This was also Hercules-powered but it did offer an alternative using two of Fairey's own P.24 units, each of which were essentially two engines coupled together through a common gearbox and driving a contra-rotating propeller. Cruise at 15,000ft would be alternatively 267mph (430km/h) and 280mph (451km/h) and, to extend the range, either of the coupled Fairey engines could be shut down with its own propeller feathered; service ceiling for the Hercules was 21,400ft (6,523m) and P.24 25,000ft (7,620m). Wing construction was orthodox and the turrets were merged into the wing and fuselage; 2,500gal (11,367lit) of fuel were carried.

Gloster B.1/39

Gloster's project had a deep wing of conventional structure which allowed all of the normal bomb loads to be housed internally, except for two 500lb (227kg) carried under the outer planes (maximum load was 9,400lb [4,264kg]). For high-altitude flight its Hercules HE.7.SMs could be replaced with turbo-blower variants but, alternatively, to improve performance the inner units could be replaced by the Centaurus. The brochure stated that, for the period, this project was planned on very progressive lines, geometrically expressing an exceptionally high standard of aerodynamic design with the front elevation approaching the ideal 'all-wing' arrangement. The turrets were positioned amidships, the upper faired into the cabin and the lower projecting from the fuselage, and the bomber would cruise at 279mph (449km/h) at 16,000ft (4,877m). Service ceiling with the Hercules was 22,700ft (6,919m) and 2,400gal (10,913lit) of fuel were carried.



Avro Type 680 powered by Bristol Hercules engines (4.39). George Jenks, Avro Heritage Centre



The Hercules powered Blackburn B.30 model.

Handley Page HP.60

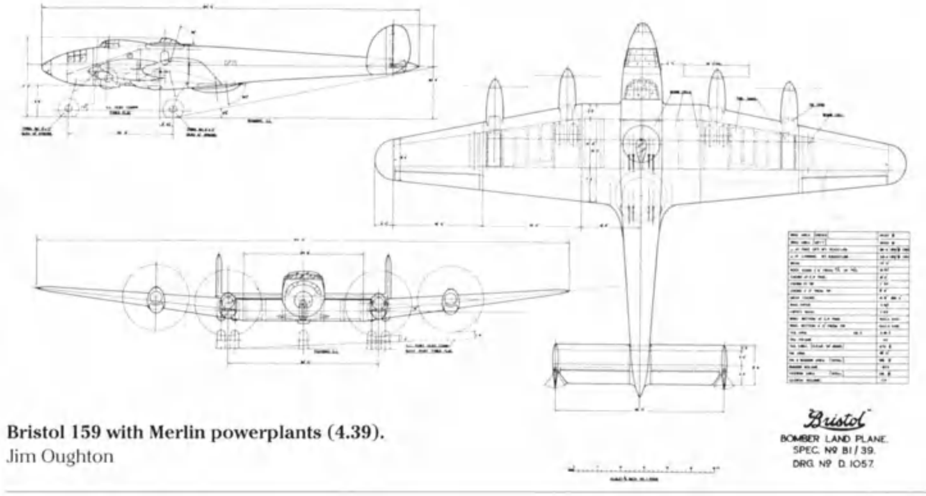
Compared to the Halifax from which it was developed, the HP.60 used a high wing; indeed, it was the only B.1/39 to utilise this arrangement which helped blend in the upper Boulton Paul turret while the lower turret projected outside the fuselage. The wing employed wide box-spar construction while a long tricycle undercarriage and a twin tail were fitted. Power came from either Hercules or Griffon which gave a respective cruise at 15,000ft (4,572m) of 280mph (451km/h) and 277mph (446km/h), service ceiling for the Hercules was 23,500ft (7,163m) and the Griffon 25,700ft (7,833m), and 2,600gal (11,822lit) of internal fuel were carried.

Shorts S.34

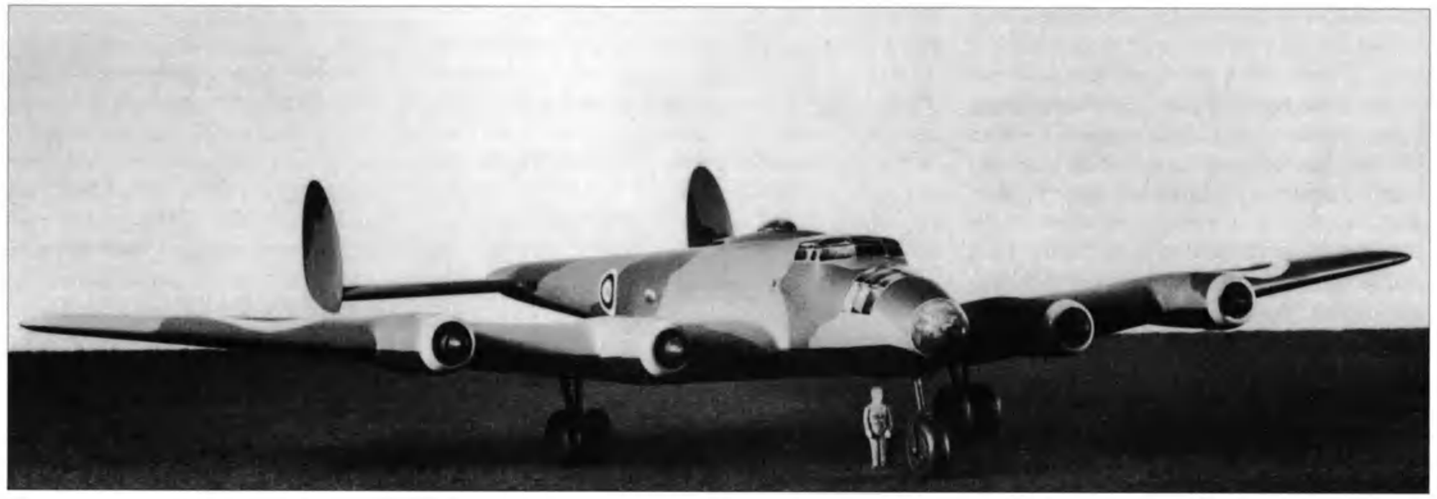
This was a mid-wing design based on the Stirling and was the only B.1/39 to feature a single fin (when fitted with Hercules engines) and a conventional tail undercarriage. Both turrets, placed one behind the other, were faired into the stressed skin box girder wing but when Griffons were fitted the S.34 reverted to twin fins and had the lower turret projecting from the fuselage. (At this stage the benefits of fully-faired turrets were unclear; in cases where they were merged into the wing surface the interference drag would be small but there might be considerable drag from the resulting thick wings). Respective cruise at 15,000ft (4,572m) was 278mph (447km/h) (Hercules) and 268mph (431km/h) (Griffon), service ceiling 23,500ft (7,163m) and 26,400ft (8,047m), internal fuel 2,600gal (11,822lit).

Vickers 405

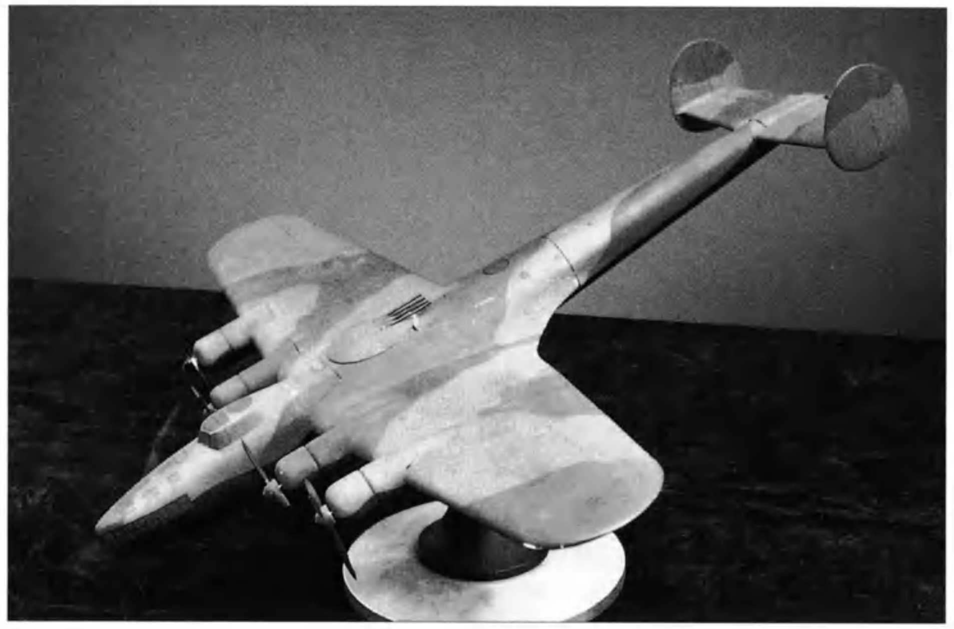
B.1/39 requested metal wing skins with no fabric covering but for its Type 405 Vickers employed a special skin of Alclad and plywood bonded with synthetic rubber. For the fuselage the company drew on its experience of geodetic construction with fabric covering but also offered an alternative all-metal project which needed a 143ft (43.6m) span to maintain the landing and take-off performance; the extra 5,000lb (2,268kg) of structure weight that this generated cut the cruise speed by 7mph (11km/h). The 405's Frazer-Nash turrets, projecting from the fuselage, were placed more to the rear than on any



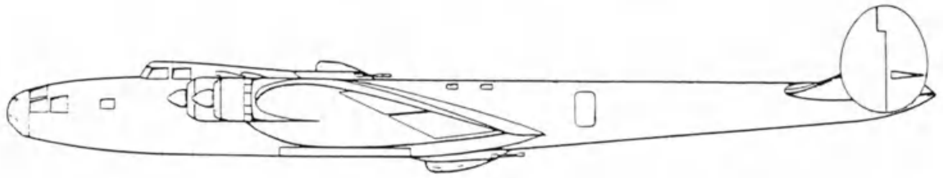
Bristol 159 with Merlin powerplants (4.39). Jim Oughton



Model of the Bristol 159. Jim Oughton



The Fairey B.1/39 model with Hercules engines (4.39).



The only known illustration of the Gloster B.1/39. Jet Age Museum

other design, an arrangement which for balance needed the engines to be set well ahead of the wing. Once again power was supplied by either Hercules or Griffon to give a respective cruise at 15,000ft (4,572m) of 284mph (457km/h) and 278mph (447km/h), and service ceiling 27,500ft (8,382m) and 30,000ft (9,144m). Internal fuel totalled 2,544gal (11,567lit) and the unusual main gears, with a main wheel housed in each of the four engine nacelles, also appeared on the company's Windsor bomber (Chapter 7).

The Air Staff's assessment of these designs showed that Fairey's B.1/39 was popular, with its superimposed turrets near the CofG and single tier bomb stowage considered to be good features, but Fairey's statement that the bombs should be dropped in a given sequence to maintain trim needed checking. Bristol's 159 had a good layout and the turrets, although not superimposed, were close enough together to provide a satisfactory layout, but the two-tier bomb stowage was a drawback. The single fin Short S.34 was disliked since the fin restricted the rear arcs of fire, but the alternative with twin fins and superimposed turrets was good. The chief fault of Gloster's project was a large blind area for the guns in the forward hemisphere.

The HP.60's turrets, which were not superimposed, had good arcs of fire but there were problems with crew communication. The AW.48 also suffered from cramped crew conditions but its armament layout was near equal to the HP.60 and the undercarriage design showed originality. However, the 405's turrets positioned well along the fuselage was thought to be a weakness because they brought a degree of vulnerability and also needed a means of conveying their ammunition from its stowage position near the CofG. This project's stern field of fire was excellent but the close proximity of the rudders gave a blind area to the beam and its structure appeared to be complicated. After the tendering stage, Blackburn produced a revised forward fuselage for its B-30 that improved the crew arrangements but not the overall design, which was seen as not entirely satisfactory because the lower gunner's view and the forward arcs of fire of the bottom guns were restricted by the undercarriage housing.

The Tender Design Conference took place on 14th June 1939. The submitted designs were, in many respects, very similar which made it difficult to arrive at a final order of priority, so instead each design was placed in one of three groups:

i. Bristol, Fairey and Handley Page – most promising,
ii. AWA, Avro and Shorts – nearly as good,
iii. Blackburn, Vickers and Gloster – unworthy of further consideration and rejected.

It was felt that the web-less spar and geodetic 'pea-pod' of the Vickers 405's wing were novel but the structure appeared complex. The design was unacceptable but its remarkably low structure weight, due to its wide spaced geodetic construction, was of great interest and further investigations were requested for other uses including a revised Warwick; however, Vickers' estimates that a stressed-skin structure would be much heavier were not understood. In fact, none of the designs had kept within the gross weight requirement and it was recommended that this should be raised to 70,000lb (31,752kg).

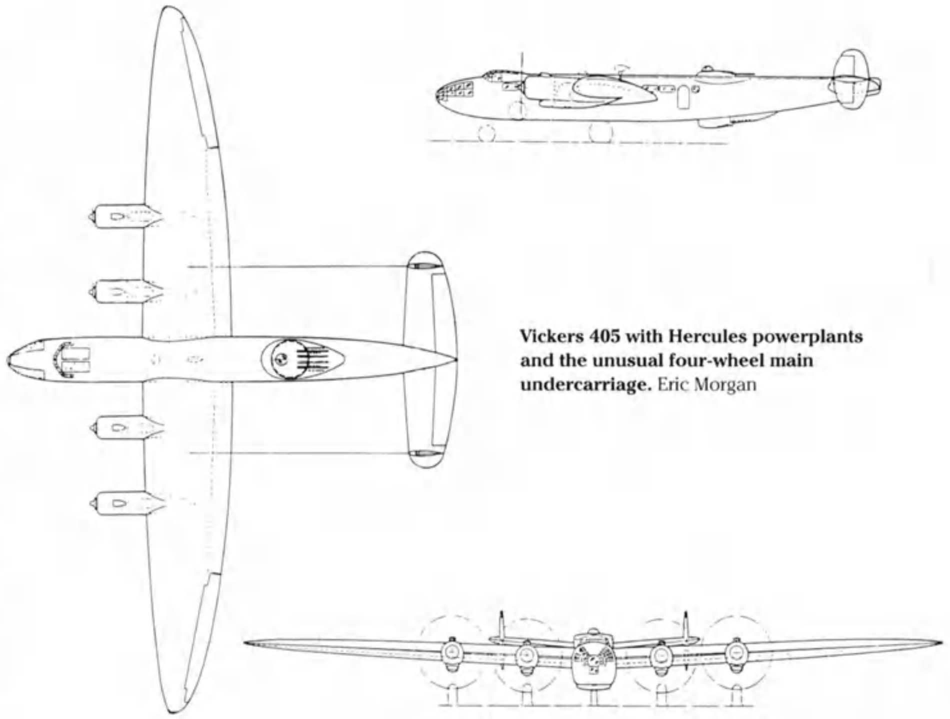
In July R Saundby, DOR, expressed his concern over proceeding with such an advanced project at this time. Originally it had not been planned to issue the Ideal Bomber requirement until experience with the Stirling, Halifax and Manchester was available for guidance but the need to occupy industry had brought the project forward. CAS reported on 13th July that the tenders indicated that B.1/39 could not be met with the powerplants, materials, structural methods and standard of aerodynamics available now or expected within two years, the chief reasons being the high cruise speed and long range but the turrets were also a source of difficulty. There were fears that an immediate go-ahead for a B.1/39 type would only result in 'fruitless work' and 'wasteful expenditure'. Roderic Hill, DTD, felt that the chances of meeting B.1/39 within two years were 'insignificant' and so developing this as a standard bomber was seen only as a long-term possibility.

On 31st July, however, DTD instructed that Handley Page and Bristol should be invited to develop their proposals, plus some half-scale flight test models, as full technical investigations; if any satisfactory results were achieved from this then prototypes of the full-scale aircraft would follow. It was also suggested that Shorts should be contacted as a source of flying model experience. AWA's promising tricycle undercarriage was to be embodied into the Albemarle and possibly the B.1/39s later (its long travel and high energy absorption was considered to be a solution to the now serious problem of landing very heavy aeroplanes) but Avro's and Fairey's projects, despite being comparatively well placed, would not be continued; neither was Shorts' since that company was so heavily committed in other directions. On 16th September Vickers was informed that it had been unsuccessful in obtaining an order but the Air Ministry wished the company to continue developing the 'wide spaced geodetic construction for which a great saving in weight is claimed'. This was followed in February 1940 by a request to proceed with the supply of an example of the main structure of the 405's proposed outer wing.

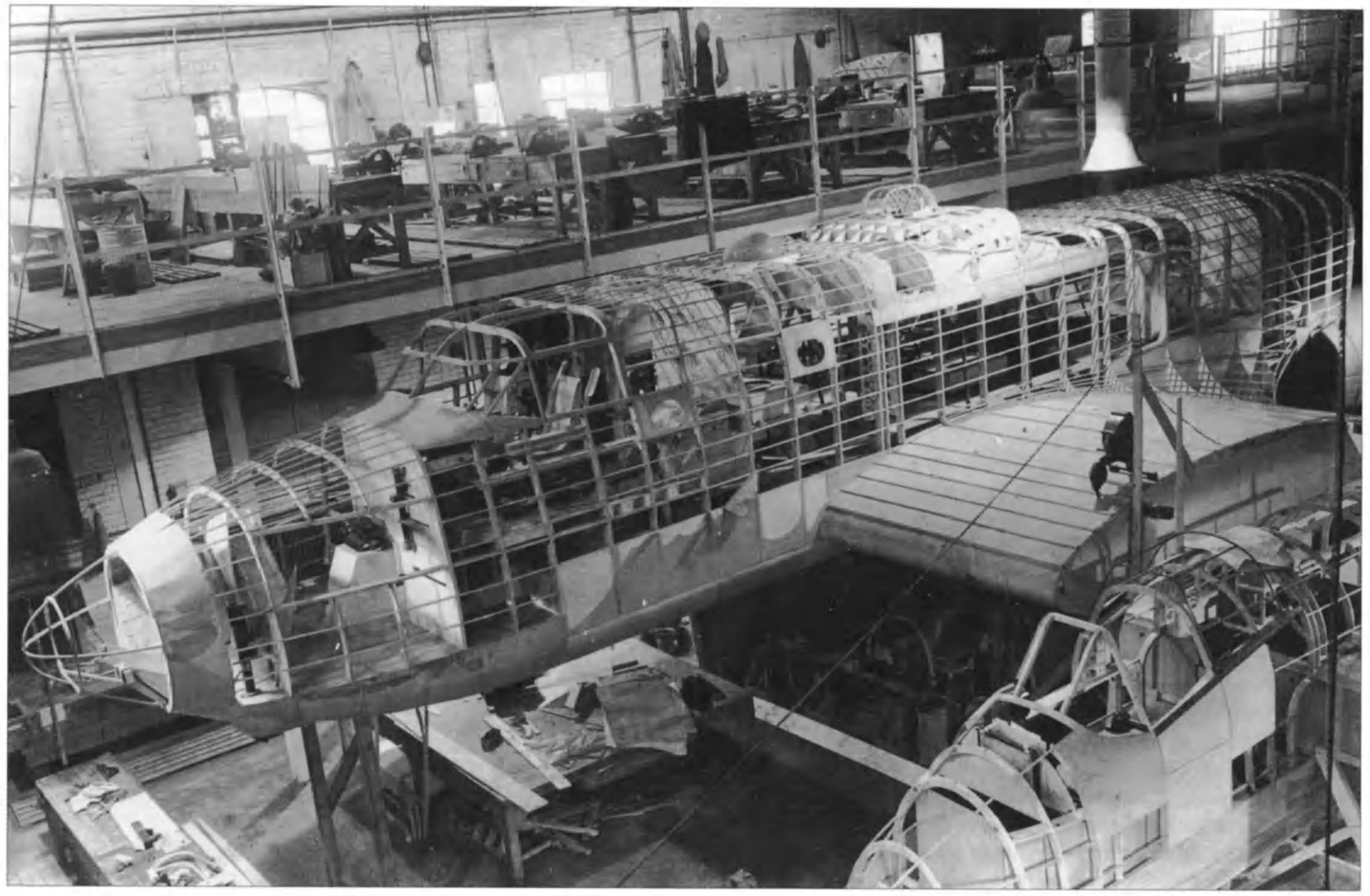
The scale models were dropped on 1st December 1939 but four full-size B.1/39 prototypes were ordered late in the month with serials X2871 and X2875 allocated to Bristol and X2880 and X2885 to Handley Page. As regards turrets and other major components, both the 159 and HP.60 were to be operationally interchangeable and detailed mock-ups of the aircraft were completed by the end of the year, at which point B.1/39 was enjoying a high priority. The Air Ministry had stipulated that Bristol and Handley Page should work in collaboration and specify the same components for their aircraft.

However on 25th May 1940, AVM Tedder, DAMDP, wrote 'in the present circumstances, we should suspend all construction activities in connection with these types' and added that staff would be better employed on more urgent needs. In mid-June the two companies were informed that all design work would cease, although none of the completed work was to be scrapped. Thus, although not killed outright by the German advance into France and MAP's consequent concentration on producing only certain types of aircraft, the Ideal Bomber was retired to obscurity, though in April 1944 it did come under consideration once more. In fact, during the design work that was completed, it was found that the aircraft's total structure weight, including the desired armament, would be too high relative to the available weight capacity left over for bombs and fuel. This problem too contributed to the prototypes being dropped. The two mock-ups were finally cleared for dismantling in January 1941.

An official post-war history notes that 'the most striking impression of the Ideal Bomber was the extraordinary ambition of the whole project, and had it reached fruition and proved successful in action this would probably have been among the most outstanding achievements in the history of aircraft design. On the other hand had the machine entered mass production and then proved to be inadequate, or even a total failure, then the results would have been catastrophic.' In the event the Halifax and Lancaster filled the gap and were to perform feats that could scarcely have been imagined in 1937 when the 'Ideal' discussions began. Perhaps the greatest value of the concept was in summarising what was known about the problems of bomber design at that time.

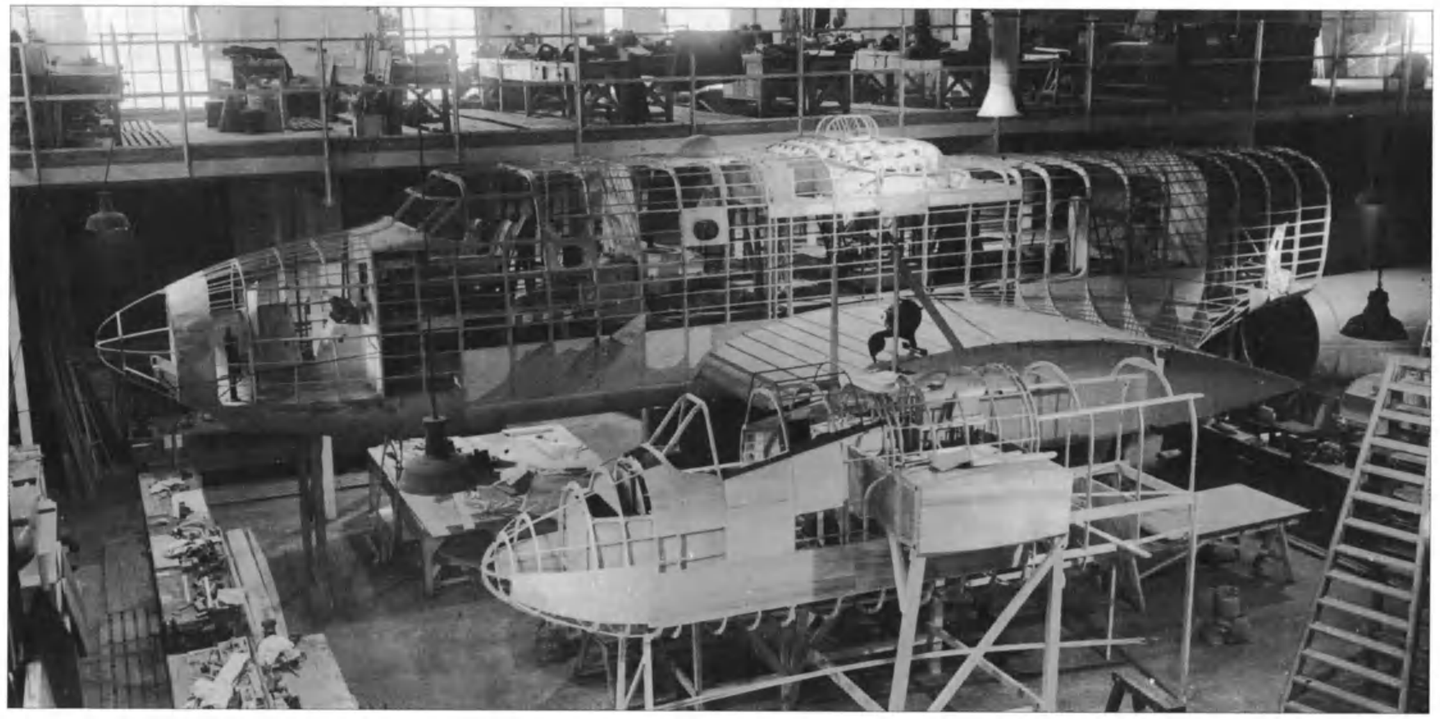


Vickers 405 with Hercules powerplants and the unusual four-wheel main undercarriage. Eric Morgan



The mock-up of the Bristol 159's forward fuselage is seen in photographs dated 14th January 1941. By the spring of 1940 the bomber's structural design was well advanced and a rear fuselage section was completed for testing; wind tunnel results revealed that the type had excellent stability and low drag.

The fuselage mock-up in the foreground is the Type 162 light bomber (tentatively named Beaumont – see Chapter 5) for which no known drawing exists. Jim Oughton

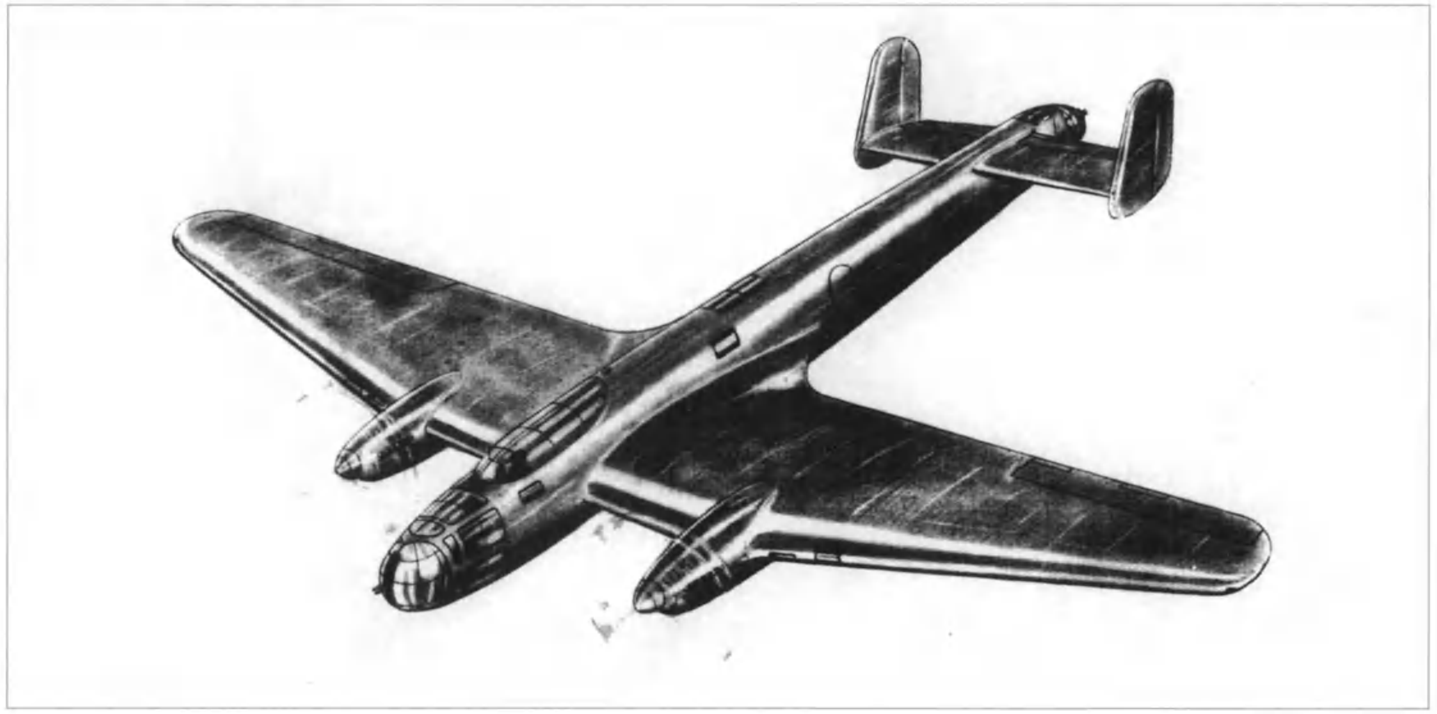


Heavy Bombers – Estimated Data

Project	*Span ft in (m)*	*Length ft in (m)*	*Gross Wing Area ft² (m²)*	*Max Weight lb (kg)*	*Engine hp (kW)*	*Max Speed / Height mph (km/h) / ft (m)*	*Armament*
Vickers Warwick B Mk.I (flown)	96 9 (29.5)	72 3 (22.0)	1,006 (93.6)	45,000 (20,412)	2 x Double Wasp R-2800 1,850 (1,380)	224 (360)	6,000lb (2,722kg) bombs, 8 x 0.303in (7.7mm) mgs
Specification B.12/36							
AWA AW.42	98 0 (29.9)	90 0 (27.4)	?	74,990 (34,015)	4 x Merlin, Vulture or Deerhound	370 (595)	41 x 250lb (113kg) or 500lb (227kg) or (probable) 7 x 2,000lb (907kg) bombs, 8 x 0.303in (7.7mm) mgs
Boulton Paul P.90	100 0 (30.5)	77 3 (23.5)	1,450 (134.9)	47,922 (21,737)	4 x Kestrel KV.26 or Dagger	290 (467) at 15,000 (4,572)	28 x 250lb (113kg) or 500lb (227kg) or 7 x 2,000lb (907kg) bombs,8 x 0.303in (7.7mm) mgs
Short S.29	102 (31.1)	86 6 (26.4)	1,300 (120.9) net	53,100 (24,086)	4 x Dagger E.108	?	20 x 250lb (113kg) or 500lb (227kg) or (probable) 7 x 2,000lb (907kg) bombs, 8 x 0.303in (7.7mm) mgs
Supermarine 316	93 0 (28.3)	71 0 (21.6)	1,240 (115.3)	51,855 (23,521)	4 x Merlin F 1,035 (772)	355 (571) at 18,000 (5,486)	29 x 250lb (113kg) or 500lb (227kg) or 7 x 2,000lb (907kg) bombs, 8 x 0.303in (7.7mm) mgs
				47,460 (21,528)	Kestrel KV.26 855 (638)	330 (531) at 17,000 (5,182)	
				54,715 (24,819)	Hercules HE.1.SM 1,300 (969)	370 (595) at 14,500 (4,420)	
				49,792 (22,586)	Pegasus XVIII 900 (671) or	330 (531) at 17,000 (5,192)	
				49,364 (22,392)	Dagger E.108 900 (671)	330 (531) at 15,000 (4,572)	
Supermarine 317	97 0 (29.6)	73 6 (22.4)	1,358 (126.3)	c55,000 (24,948)	4 x Hercules HE.1.SM 1,315 (981)	360 (579) at 14,500 (4,420)	As per Type 316
Supermarine 318	97 0 (29.6)	73 6 (22.4)	1,358 (126.3)	52,611 (23,864)	4 x Merlin C 1,050 (783)	345 (555) at 16,000 (4,877)	As per Type 316
Vickers 293	100 0 (30.5)	81 6 (24.8)	1,290 (120.0)	50,370 (22,848)	4 x Kestrel KV.26 855 (638)	297 (478) at 17,000 (5,182)	30 x 250lb (113kg) or 500lb (227kg) or 7 x 2,000lb (907kg) bombs, 8 x 0.303in (7.7mm) mgs
				51,880 (23,533)	Taurus TE.1.R 855 (638) or	291 (468) at 17,000 (5,182)	
				51,900 (23,542)	Dagger E.108 900 (671)	297 (478) at 15,000 (4,572)	
Short S.29 (revised 4.37)	100 0 (30.5)	86 8 (26.4)	1,300 (120.9) net	56,000 (25,402)	4 x Hercules HE.1.SM or Dagger E.108		28 x 250lb (113kg) or 500lb (227kg) or 7 x 2,000lb (907kg) bombs, 8 x 0.303in (7.7mm) mgs
Bristol B.12/36	110 0 (33.5)	80 0 (24.4)	?	?	4 x Hercules HE.3.SM 1,450 (1,081)	331 (533) at 15,000 (4,572)	28 x 250lb (113kg) or 500lb (227kg) or 7 x 2,000lb (907kg) bombs, 8 x 0.303in (7.7mm) mgs
Short S.29 Stirling B Mk.I (flown)	99 1 (30.2)	87 3 (26.6)	1,300 (120.9)	70,000 (31,752)	4 x Hercules	282 (454) at 12,500 (3,810)	14,000lb (6,350kg) bombs, 8 x 0.303in (7.7mm) mgs
Specification P.13/36							
Avro 679	72 0 (21.9)	69 0 (21.0)	?	?	2 x Vulture	?	8,000lb (3,629kg) bombs, 6 x 0.303in (7.7mm) mgs
Boulton Paul P.91	83 0 (25.3)	71 3 (21.7)	950 (88.4)	35,734 (16,209)	2 x Vulture	321 (516) at 15,000 (4,572)	16 x 250lb (113kg) or 500lb (227kg) or 4 x 2,000lb (907kg) bombs, 6 x 0.303in (7.7mm) mgs
Bristol P.13/36	79 0 (24.1)	55 9 (17.0)	800 (74.4)	32,137 (14,577)	2 x Hercules HE.3.SM	315 (507) at 15,000 (4,572)	16 x 250lb (113kg) or 500lb (227kg) or 4 x 2,000lb (907kg) bombs, 6 x 0.303in (7.7mm) mgs
Fairey P.13/36	85 0 (25.9)	55 0 (16.8)	?	38,678 (17,544)	2 x P.24 1,750 (1,305)	327 (526) at 15,000 (4,572)	4,000 lb (1,814kg) bombs 6 x 0.303in (7.7mm) mgs
Handley Page HP.56	88 0 (26.8)	66 6 (20.3)	975 (90.7)	c39,000 (17,690)	2 x Vulture X	320 (515)	8,000lb (3,629kg) bombs, 6 x 0.303in (7.7mm) mgs
Hawker P.13/36	87 0 (26.5)	72 8 (22.1)	1,285 (119.5)	?	2 x Vulture	?	8,000lb (3,629kg) bombs, 6 x 0.303in (7.7mm) mgs
Shorts P.13/36	No data available						

Avro 679 Manchester B Mk.I (flown)	90 1 (27.5)	68 10 (21.0)	1,131 (105.2)	c50,000 (22,680)	2 x Vulture I 1,760 (1,312)	265 (426) at 17,000 (5,182)	normal 8,000lb (3,629kg), max 10,350lb (4,695kg) bombs, 8 x 0.303in (7.7mm) mgs
Handley Page HP.57 Halifax B Mk.I (flown)	98 8 (30.1)	70 1 (21.4)	1,250 (116.3)	55,000 (24,948)	4 x Merlin X 1,130 (843)	262 (422) at 18,000 (5,486)	13,000lb (5,897kg) bombs max, 8 x 0.303in (7.7mm) mgs
Avro 683 Lancaster B Mk.I (flown)	102 0 (31.1)	68 10 (21.0)	1,300 (120.9)	68,000 (30,845)	4 x Merlin XX 1,460 (1,089)	281 (452) at 11,000 (3,353)	14,000lb (6,350kg) bombs max, 8 x 0.303in (7.7mm) mgs
Avro 684	102 0 (31.1)	72 0 (21.9)	1,297 (120.6)	60,000 (27,216)	4 x Merlin XX, plus 1 x Merlin 45 (slave)	410 (660) at 42,500 (12,954)	12,000lb (5,443kg) bombs, no defensive armament carried
Specification B.1/39	*(weight and top speed are for 2,500 miles [4,023km] range)*						
AWA AW.48	104 0 (31.7)	85 0 (25.9)	1,660 (154.4)	73,060 (33,140)	4 x Griffon 1,560 (1,163)	342 (550) at 15,000 (4,572) (Top 351 [565] at 17,000 [5,182])	10,500lb (4,763kg) bombs, 8 x 20mm cannon
Avro 680	120 0 (36.6)	95 6 (29.1)	1,835 (170.7)	76,230 (34,578)	4 x Hercules HE.6.SM or Griffon or 2 Vulture + 2 Merlin	324 (521) at 15,000 (4,572) (Hercules)	9,000lb (4,082kg) plus bombs, 8 x 20mm cannon
Blackburn B.30	104 0 (31.7)	83 6 (25.5)	1,814 (168.7)	76,350 (34,632) (Hercules) 74,750 (33,907) (Griffon)	4 x Hercules HE.7.SM or ducted radiator cooled Hercules or Griffon	296 (476) (Hercules) at 15,000 (4,572) 303 (488) (Griffon) at 15,000 (4,572)	9,000lb (4,082kg) plus bombs, 8 x 20mm cannon
Bristol 159	114 6 (34.9)	80 3 (24.5)	1,800 (167.4)	77,860 (35,317) (Hercules) 76,270 (34,596) (Griffon)	4 x Hercules HE.7.SM or Griffon	302 (486) (Hercules) 303 (488) (Griffon) at 15,000 (4,572)	15,000lb (6,804kg) bombs, 8 x 20mm cannon
Fairey B.1/39	115 0 (35.1) 124 0 (37.8)	93 6 (28.5) 90 0 (27.4)	2,090 (194.4) 2,390 (222.3)	79,400 (36,016) 90,130 (40,883)	4 x Hercules HE.7.SM or 2 x P.24	285 (459) 315 (507) at 15,000 (4,572)	9,000lb (4,082kg)+ bombs, 8 x 20mm cannon
Gloster B.1/39	115 6 (35.2)	91 6 (27.9)	2,040 (189.7)	78,690 (35,694)	4 x Hercules HE.7.SM	289 (465) at 15,000 (4,572) (Top 301 [484] at 16,000 [4,877])	9,400lb (4,264kg) bombs, 8 x 20mm cannon
Handley Page HP.60	115 0 (35.1)	92 6 (28.2)	1,815 (168.8)	77,090 (34,968) 75,350 (34,179)	4 x Hercules HE.7.SM or Griffon	300 (483) 315 (507) at 15,000 (4,572)	9,000lb (4,082kg)+ bombs, 8 x 20mm cannon
Short S.34	113 8 (34.6)	93 9 (28.6)	1,746 (162.4)	77,500 (35,154) 75,850 (34,406)	4 x Hercules HE.7.SM or Griffon	298 (479) 306 (492) at 15,000 (4,572)	9,000lb (4,082kg)+ bombs, 8 x 20mm cannon
Vickers 405	133 0 (40.5)	84 6 (25.8)	1,770 (164.6)	82,500 (37,422) 80,710 (36,610)	4 x Hercules HE.7.SM or Griffon	300 (483) 319 (513) at 15,000 (4,572) (Top 312 [502] at 17,500 [5,334] Hercules, 332 [534] at 18,000 [5,486] Griffon)	9,000lb (4,082kg)+ bombs, 8 x 20mm cannon

Impression of the Fairey P.13/36 (late 1936). Bill Harrison



Chapter Seven

Heavy Bombers Part II

Vickers Windsor prototype DW506. Eric Morgan

Specification B.8/41 Short 'Super Stirling'

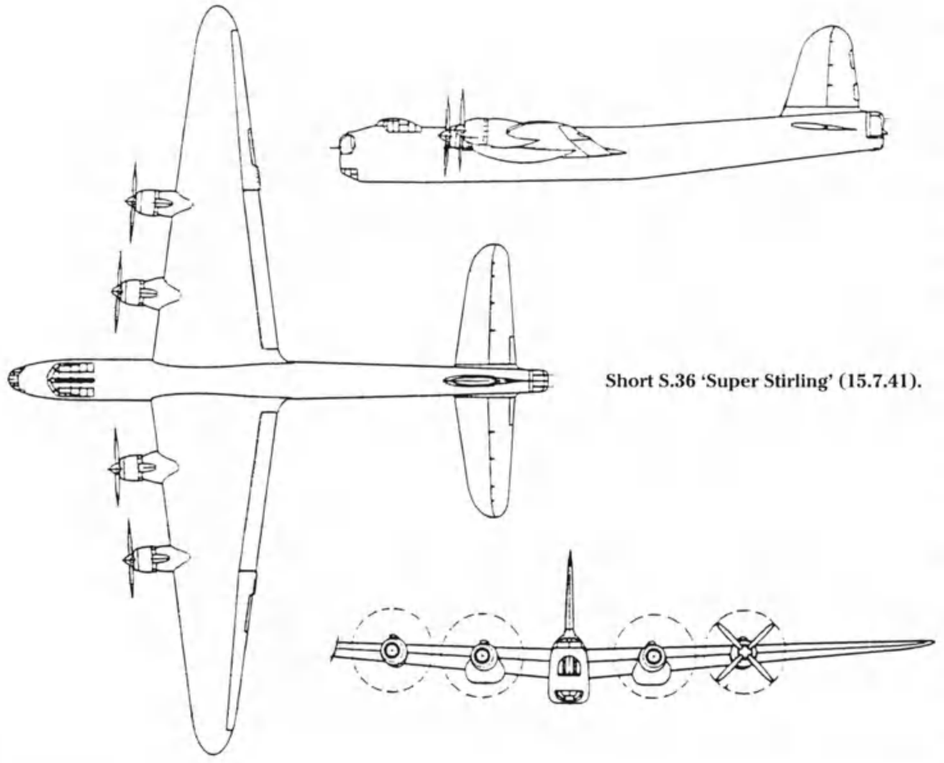
In 1941 the growing strength of the Halifax and Lancaster ahead of the Stirling forced Shorts to consider a major development of its bomber; the result was a project often called the 'Super Stirling'.

Short S.36

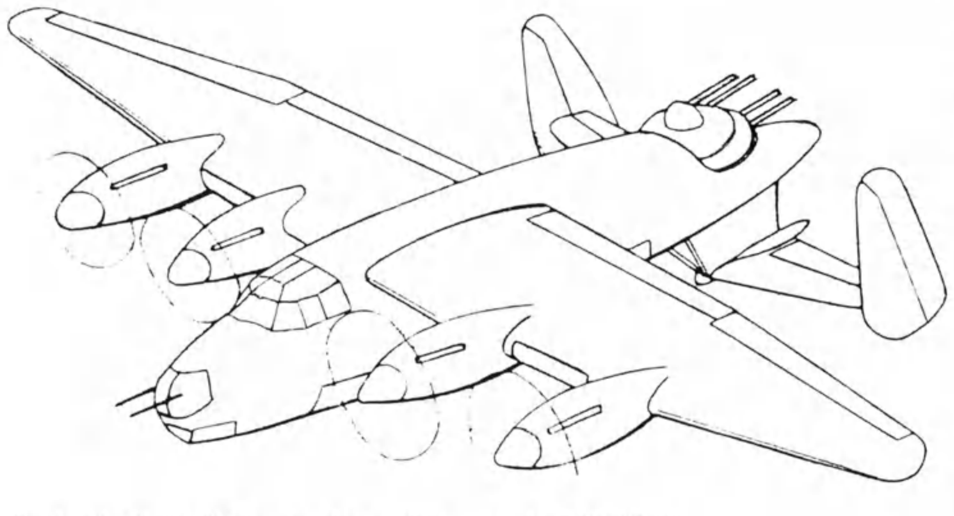
The key element was the introduction of Centaurus CE.3.SM radials instead of the Hercules. The S.36 had redesigned wings and a longer fuselage which featured a large central bomb bay for various loads, including one 8,000lb (3,629kg) weapon; this represented a big improvement over the Stirling's individual bomb cells while six more wing cells could each take a 1,000lb (454kg) bomb. There were also changes to the empennage but a large proportion of the 'bits and pieces' used in the fuselage were retained. CRD described the new type as 'a typical night bomber having high useful load at a comparatively slow, economical cruising speed' (214mph [344km/h] at 15,000ft [4,572m], just 6mph [10km/h] more than the Stirling) but he recommended that a production order should be placed. The S.36 had a defensive armament of two 0.5in (12.7mm) machine guns in the nose, four more in both mid-upper and tail turrets plus an under turret with two 0.303in (7.7mm) machine guns. It was not seen as an all-new type, but shared a 'general similarity' to the Stirling.

The first estimates, for what the designers called the 'Stirling III', were completed on 15th July 1941 and gave an all-up-weight of 103,100lb (46,766kg), and at 80,000lb (36,288kg) weight a top speed of 311mph (500km/h) at 20,000ft (6,096m) and service ceiling 29,300ft (8,931m). A month later Liptrot revised this to 105,000lb (47,628kg) and 295mph (475km/h) at 20,000ft (against 70,000lb [31,752kg] and 282mph [454km/h] at 12,500ft [3,810m] for the Stirling), but he considered the project 'to be well conceived and to be a logical next stage in the development of the heavy bomber'. The project was seen to have a similar take-off and flight performance to the Stirling but with much increased bomb load/range characteristics. Over 1,000 miles (1,609km) the S.36 could carry 23,500lb (10,660kg) of bombs against the Stirling's 14,000lb (6,350kg); for 2,300 miles (3,701km) range it could take 10,000lb (4,536kg) against 4,500lb (2,041kg).

On 19th November Specification B.8/41 was raised to cover the project but, from the point of view of heavy bomber production, some within the Ministry were apprehensive about introducing the new type. The Controller General stated that the present Stirling is not designed for larger scale production as efficiently as the Halifax or Lancaster and it would be better to ask Handley Page or Avro to design a super bomber. However, on 27th December CRD declared that he wanted to order two B.8/41 prototypes as soon as possible, and on 9th January 1942 discussions between Messrs Gouge and McPhie of Shorts, DTD and CRD led to the decision to order two prototypes, the first without certain operational equipment but the second complete. Serials JR540 and JR543 were allotted to them



Short S.36 'Super Stirling' (15.7.41).



Sketch of the Westland Delanne bomber possibly prepared to B.8/41 (10.41).
Fred Ballam, Westland

and it was estimated that the first would fly in autumn 1943. Shorts was also told that it could prepare jigs for building twenty aircraft a month and an initial order for 150 was discussed.

On 11th May CinC Bomber Command, Air Chief Marshal Sir Arthur Harris, wrote that the B.8/41 was expected 'to eradicate the weakness of the present Stirling and with much bigger span wings should be a better aircraft. But the new potential given does not justify the change over – the switch will cost 126 Stirlings at Rochester plus a build ratio of two B.8/41s for three Stirlings. The best course is to concentrate on the Hercules VI Stirling which will go a long way to improving the really weak feature – its operating ceiling at weak mixture. The Hercules VI should push this up to 19,000ft [5,791m] from 16,000ft [4,877m] which is superior to the B.8/41.'

Two weeks later Shorts was told to cease work on the project, the Air Ministry having decided not to proceed with it. Four days later Gouge was told that the project was dead, the Air Staff having estimated that by the time the B.8/41 was in service, and taking into account the increases in additional weight that inevitably go on a new aircraft, the gain in performance and bomb load that it offered would be insufficient to justify the losses of standard production Stirlings. A further argument was that the Minister wanted the replacement for the RAF's contemporary heavy bombers to be limited to a single type. On 5th August, after further consideration, Shorts decided not to proceed with the investigation, but it would continue with the addition of the split flap to the Gouge flap to minimise drag for landing. Quite an amount of work had already been done on this feature using the S.31 half-scale Stirling and the results were very promising.

Westland 'B.8/41'

It is thought that a heavy bomber design produced by Westland in October 1941 was also drawn to this specification. This was one of the company's Delanne efforts and was powered by four 1,500hp (1,119kW) Griffons. Span was 113ft (34.4m), all up weight 70,000lb (31,752kg), wing area $1,275ft^2$ ($118.6m^2$) and cruise speed 300mph (483km/h) at 20,000ft (6,096m), and the defensive armament included a nose turret with two machine guns and a four cannon rear turret. The Delanne wing arrangement featured on a number of Westland's wartime projects, the rear wing having an area of 50% of the mainplane. Both acted as lifting surfaces and the idea was to give the aircraft a large range of CofG.

Vickers-Armstrongs Windsor

The final piston-engined bomber to be built and flown by Vickers was also the company's last bomber to use geodetic construction. This aircraft's story, however, begins with a twin-engined medium bomber.

Vickers Medium Bomber

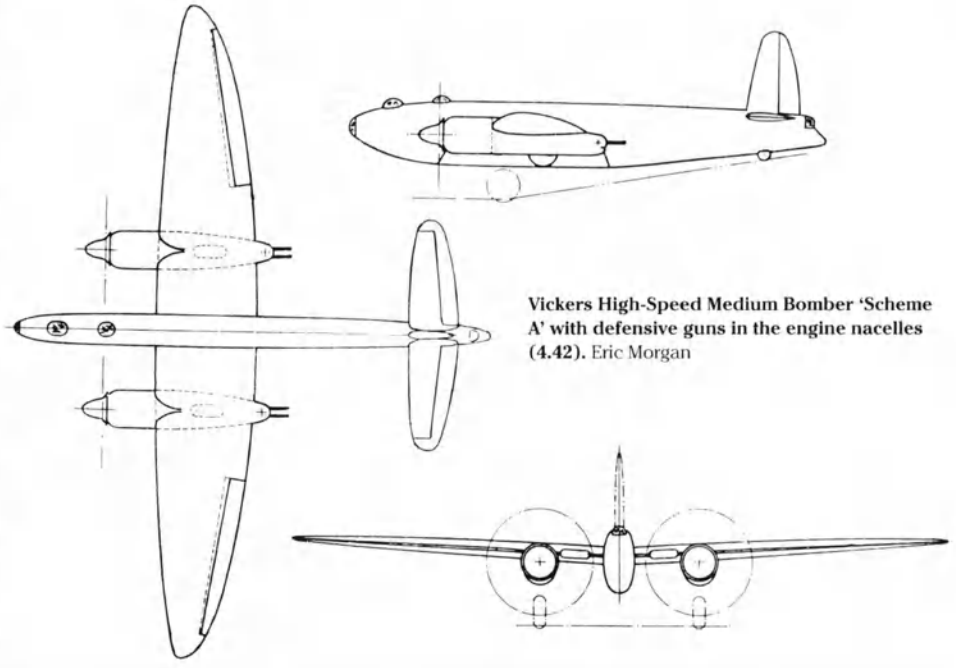
Between April and June 1942, following discussions with DTD on a proposed replacement for the Wellington Mk.X, Vickers chief designer Rex Pierson produced a set of brochures for a twin-engined slim fuselage high-speed medium bomber. These were based on the requirements of both B.11/41 and the Bristol Buckingham production specification (Chapter 5) and the first brochure was completed on 22nd April. It defined a project (Scheme 'A') with five crew, a 4,000lb (1,814kg) bomb load, 1,600 miles (2,574km) range, a single fin and, for defence, a twin 0.5in (12.7mm) remotely-controlled turret placed in the rear of each engine nacelle. Rate of climb at sea level was 1,950ft/min (594m/min), time to 25,000ft (7,620m) 22.0 minutes and service ceiling 33,400ft (10,180m). Geodetic construction would have been used and 955gal (4,342lit) of fuel were carried. The primary powerplant was the Bristol Centaurus VII, but the 1,640bhp (1,223kW) Rolls-Royce Griffon 61 was an alternative which gave a total weight of 33,510lb (15,200kg), a maximum speed (at mean weight) of 390mph (628km/h) at 26,500ft (8,077m), sea level rate of climb 1,700ft/min (518m/min), 27 minutes to 26,500ft and service ceiling 33,000ft (10,058m).

This brochure was never issued because on 6th May the design was refined for MAP's Capt Liptrot; Scheme 'B' was essentially the same design but had extra defence in the form of four more guns in a solid nose. On 26th May DOR declared that the proposal was unacceptable because it had neither the speed required for an unarmed bomber nor adequate armament as an armed bomber. Shortly afterwards Scheme 'C' was drawn which was a heavy bomber version powered by four Merlin 61s. The all-up-weight of this project was 55,000lb (24,948kg), maximum load 8,000lb (3,629kg) bombs, maximum speed 385mph (619km/h) and cruise 330mph (531km/h), both at 23,000ft (7,010m), and range with a 4,000lb (1,814kg) load 1,600 miles (2,575km). MAP suggested that four Merlins to a larger airframe might give a higher speed and allow a bigger bomb load, which would be attractive if it was operated primarily in Europe.

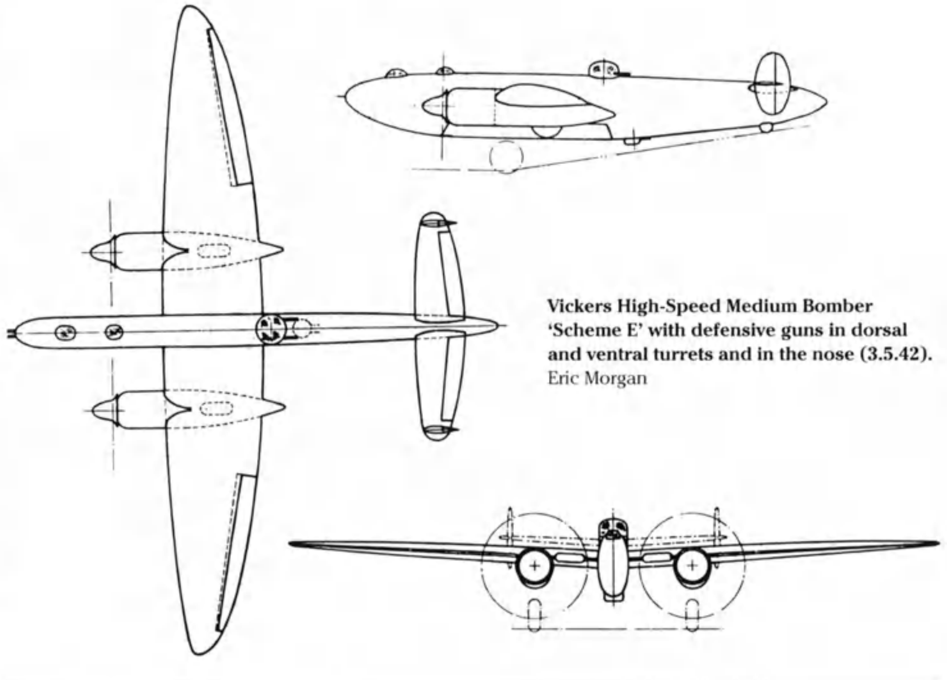
On 2nd June Wilfrid Freeman appraised these projects and also observed that Vickers must not go on building the Wellington forever. In 1944 the Mk.X would be obsolete but Vickers was committed to geodetics and was, therefore, unable to build any other design but its own. Vickers' factories were laid out for geodetic construction and it was felt essential that a new type should be suited to this form in order to avoid a great loss of productive effort. Scheme 'A' was a only small step forward in bomb load and defence over the Wellington while Scheme 'B' had an improved defence but much the same bomb load. In performance 'A' was much better than the Wellington and roughly equivalent to the Buckingham but was inferior to both in armament – the four 0.5in (12.7mm) remotely-controlled guns behind the engines were 'a most conspicuous disadvantage' which, owing to the size of the fuselage and the balance of the aircraft, would preclude any additional guns to be added later.

Scheme 'B' had started as a heavy twin but could soon become overloaded by additions to its weight during building and in service, while 'C' showed a considerable improvement over the Lancaster in speed and had a tail turret with four 0.5in guns, but it was a little down in bomb load and range. Freeman felt the balance of advantage seemed to lie with 'C' which had a better bomb load and potential range than either 'A' or 'B', coupled with a greater reserve to allow for development and additional weight. The four-engine model resulted in a heavy instead of a medium bomber and would be a logical line of progress and he recommended that the Wellington X should be replaced by a heavy along the lines of Scheme 'C'.

Vickers' final twin-engine proposal was formulated and submitted on 9th June 1942. The basic layout was still the original design but it now had twin fins, plus dorsal and ventral turrets to replace the nacelle guns; 'Scheme D' had the original glass nose, 'E' the four extra



Vickers High-Speed Medium Bomber 'Scheme A' with defensive guns in the engine nacelles (4.42). Eric Morgan

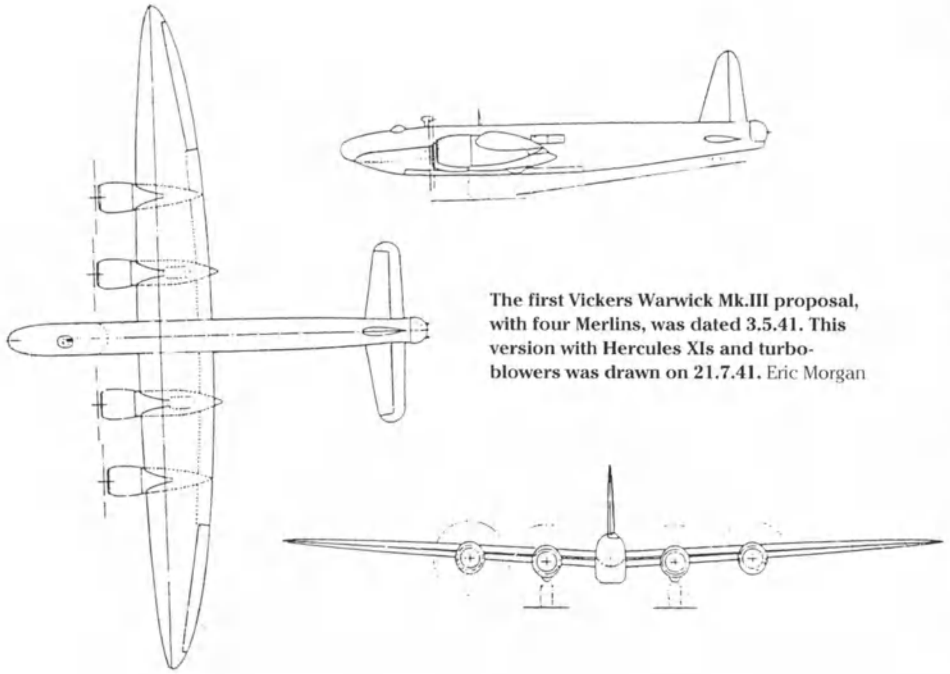


Vickers High-Speed Medium Bomber 'Scheme E' with defensive guns in dorsal and ventral turrets and in the nose (3.5.42).
Eric Morgan

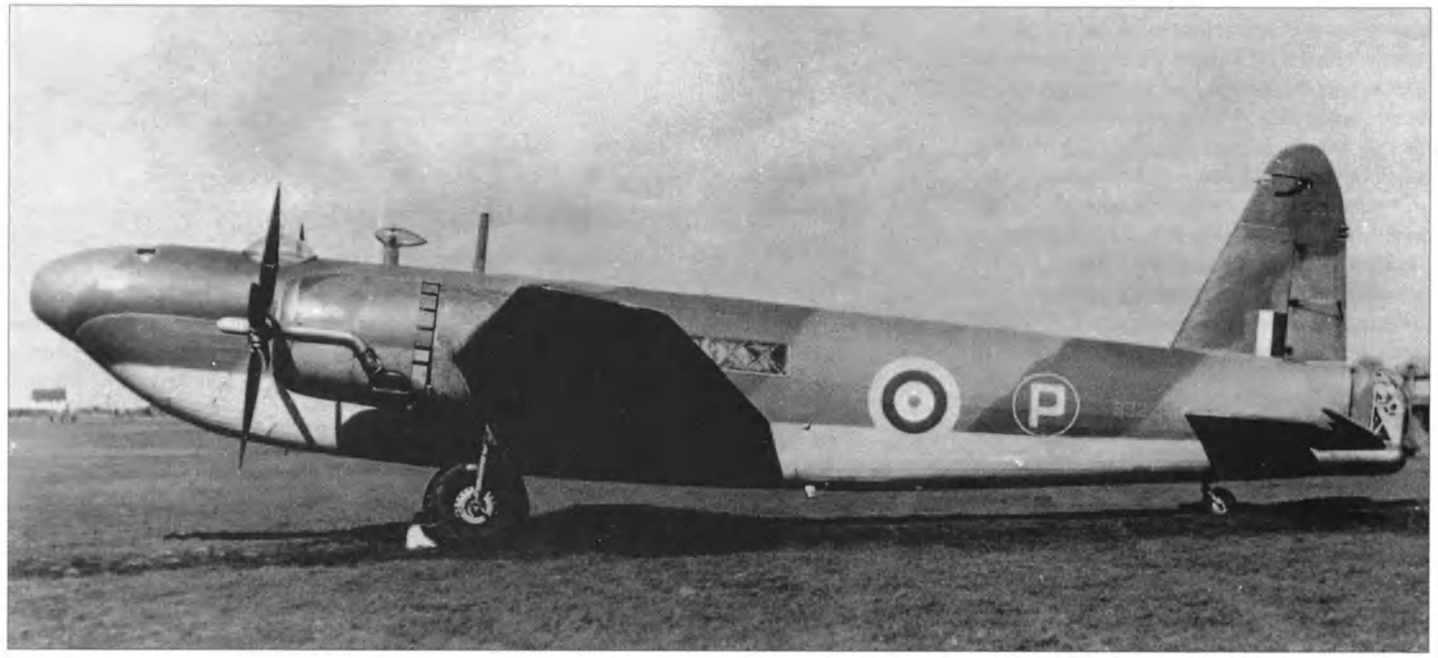
nose guns. The same engines were used and the Centaurus variant weighed 37,300lb (16,919kg), carried a maximum 8,000lb (3,629kg) of bombs, and with a 4,000lb (1,814kg) load had a range of 1,550 miles (2,494km). The project was seen in some eyes as a geodetic version of the Bristol Buckingham. Pierson visited Filton to look at the Buckingham mock-up and the Centaurus installation while Bristol also supplied some Buckingham data, but no orders were forthcoming. The Air Ministry had quite liked the Wellington replacement but suddenly changed its requirements to a four-engine type. However, Vickers was already working on a high-altitude bomber with four Merlins to B.5/41 and the draft drawings indicated that the basic layout of its twin-engined medium bomber could be incorporated into the larger aircraft.

Vickers 433 Warwick III

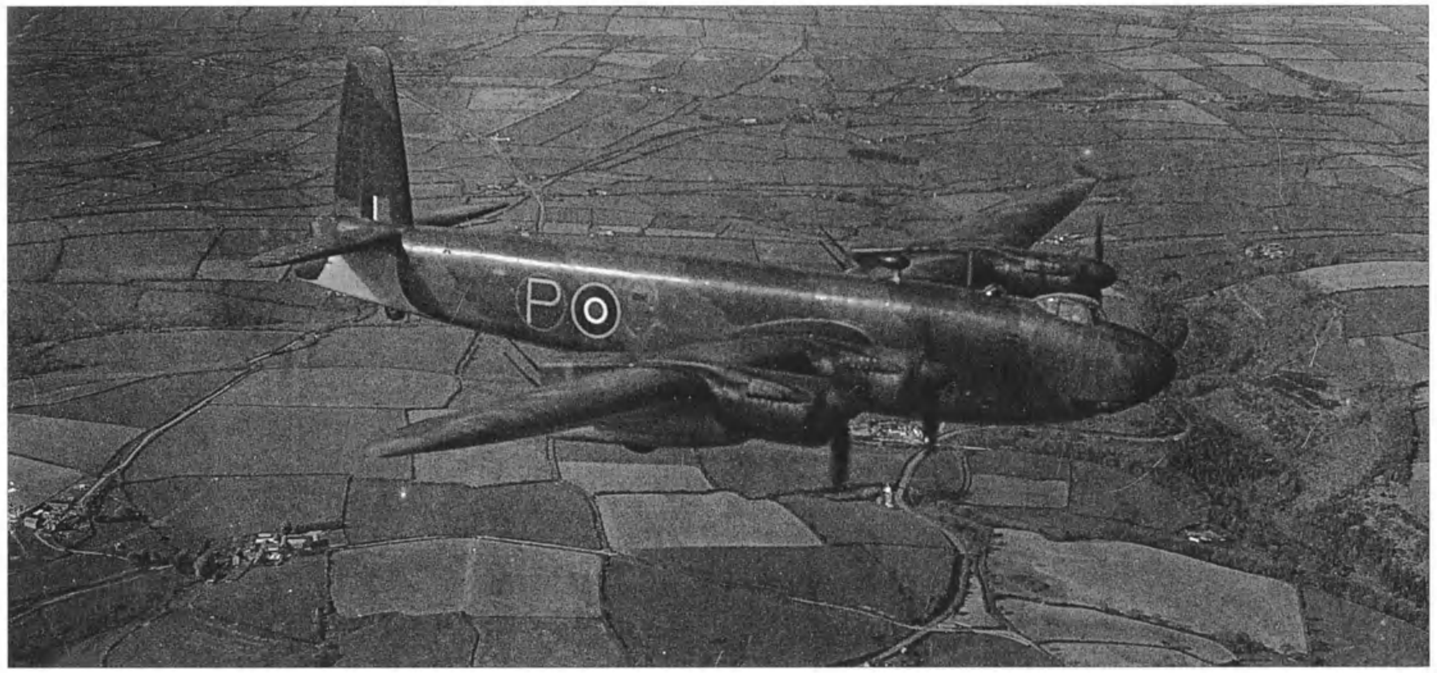
The Wellington Mk.V was an experimental variant of Vickers' successful medium bomber fitted with a pressure cabin and, as the development work on it matured in late 1940, the Air Staff became interested in a comparable pressurised version of the Warwick. Draft proposals from Vickers were prepared and discussed at the Ministry and on 9th January 1941 Lord Beaverbrook wrote 'High altitude bombers are to be developed intensively. I wish you to undertake this work. The Wellington V is to be fully developed with Hercules and Merlin engines (with the Merlin to take precedence) [and] the B.1/35 [Warwick] is to have a pressure cabin; the work is to be pursued urgently'. Detailed proposals were submitted to the Ministry in May and during the initial stages the project was known as the Warwick Mk.III. The fuselage was very similar to the Mk.V Wellington but the standard Warwick wings were replaced by an elliptical wing and four Merlin LX engines with ducted wing radiators. The cabin accommodated three crew and there was also a separate pressurised tail turret containing four 0.303in (7.7mm) machine guns and its gunner. The aircraft was predicted to have a range of 2,000 miles (3,218km) with 8,000lb (3,629kg) of bombs; at the end of its mission the service ceiling would be 43,500ft (13,259m).



The first Vickers Warwick Mk.III proposal, with four Merlins, was dated 3.5.41. This version with Hercules XIs and turbo-blowers was drawn on 21.7.41. Eric Morgan

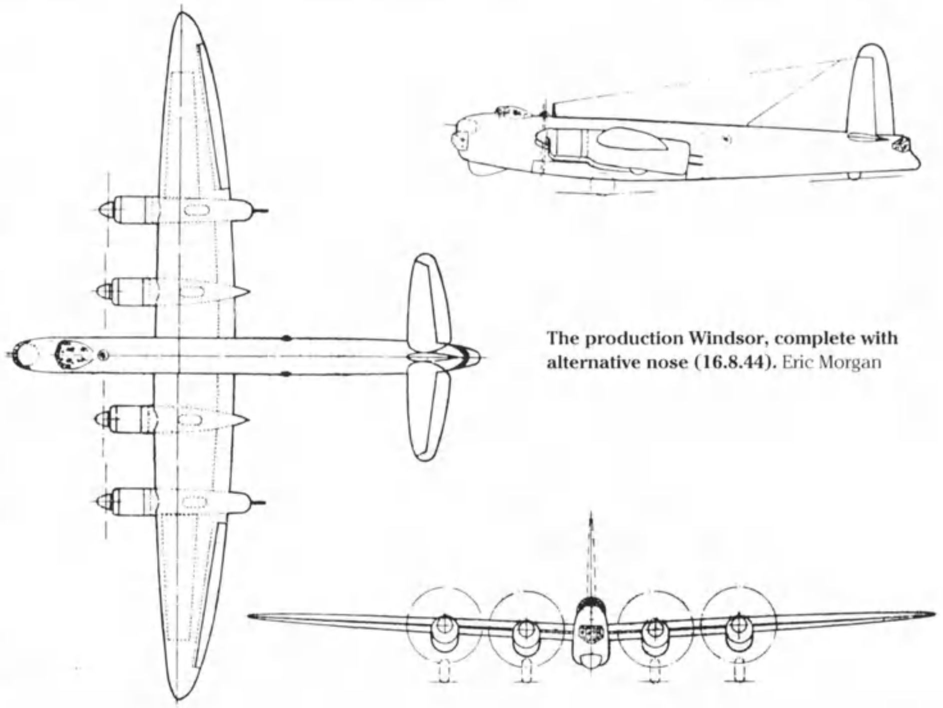


High-altitude Wellington Mk.V R3298 with pressure cabin nose. Eric Morgan



The third Windsor prototype NK136 featured different engine cowlings and carried defensive guns in the rear of the outer nacelles. Eric Morgan

In July a contract was placed for two prototypes, DW506 and DW512 both with four Merlin 60s, and in October Specification B.5/41 was drafted to cover the design. It called for a pressure cabin bomber with a maximum speed of not less than 345mph (555km/h) at 31,000ft (9,449m) and service ceiling of not less than 38,500ft (11,735m); the bomb load was to be 8,000lb (3,629kg). The B.5/41 had a much larger pressure cabin than the Wellington and on 13th July DTD wrote 'the immediate objective is to introduce this new type as a high-speed bomber, at oxygen heights and without pressure, into production as rapidly as possible'. A Design Conference was held on 8th October and the project continued with mock-up work and model experiments until 16th September 1942, when it was axed because of the appearance of a new bomber design to Specification B.3/42 and a consequent rearrangement of contracts. This later design was described as a Lancaster replacement and removed the high-altitude performance requirements.



The production Windsor, complete with alternative nose (16.8.44). Eric Morgan

Vickers 447 Windsor

The B.3/42 resulted from the merger of the B.5/41 and the twin-engine Wellington replacement project. Vickers declared that it could not do the four-engine job at the required weight, so the weight limitations were dropped and it then became possible to combine the two designs. It was also possible to 'lift' most of Vickers' work on the B.5/41 into the B.3/42 since the new design had the same engines and wings but a different fuselage (for example a great deal of the calculations could be applied); however, all of the work on the pressure cabin was wasted. Vickers called the project its Type 447 and, for stressing purposes, B.3/42 requested a maximum speed of 350mph (563km/h) EAS.

The two prototypes, which retained the original serials, were to be joined by two more, MP829 and MP832 ordered on 4th July 1942 (in fact these were never built). The B.3/42 Mock-Up Conference took place on 29th and 30th October, another prototype, NK136, was ordered on 10th December and on 1st January 1943 J E Serby notified Vickers of the extension of the contract to include the prototypes plus two pre-production aircraft (NN670 and NN673). This was followed on 21st April by a production order for 300 aeroplanes to be built at Weybridge and in the autumn the new bomber was called the Windsor B Mk.I. The first prototype DW506 made its maiden flight on 23rd October 1943 but the first two machines had to be limited to 55,000lb (24,948kg) all-up-weight because they had been too far advanced in construction for the additional strengthening to be incorporated that would take them up to B.3/42 standards.

The bomber's defensive armament was the subject of extensive investigation and controversy. In August 1942 a combination was established of two fixed 0.303in (7.7mm) machine guns in the nose plus two 20mm cannon in a turret at the extreme rear of the fuselage but, in due course, the tail turret was dispensed with and the vacant position used as a sighting and control station for two barbettes, one at the rear of each outer engine nacelle, which each contained two rearward-firing 20mm guns. This later arrangement was officially adopted on 15th February 1943 and in 1944 the second Warwick prototype, L9704, was used to test it, but with 0.5in (12.7mm) machine guns fitted in lieu of the 20mm. In April 1944 it was also decided to provide stations for amidships beam guns as supplementary armament.

Initially the barbettes were to be fitted to the fourth Windsor but these were brought forward to go on NK136, which had now become the third prototype. This aircraft, known as the Type 461 and powered by Merlin 65s, was to be the only other Windsor to fly after DW406 and DW412 (on 11th July 1944) and it was much closer to the production standard; the remotely-controlled guns were not fitted until 1945 but they were used in firing tests until 1946. The weight of the barbettes raised problems over the aeroplane's CofG and the favoured solution was an extended nose. The single pilot cockpit also caused controversy because, in an emergency, access to the pilot's station by another crew member was near impossible. As a result on 16th August 1944 a drawing was produced showing the Windsor with a new nose based on an RAE 'Lancaster' design; here a seated bomb aimer controlled a twin 0.5in (12.7mm) turret behind which came the pilot's cockpit with side-by-side seating. All-up-weight was now 80,000lb (36,288kg).

It was expected that the Windsor, starting at some 75,000lb (34,020kg) all-up-weight, would be capable of development to something approaching 84,000lb (38,102kg), when the Mk.IV Lancaster (the Lincoln, see below) would probably reach the limit of its development at 75,000lb. The Windsor was 10mph to 20mph (16km/h to 32km/h) faster than the Lancaster IV and, with a maximum 12,000lb (5,443kg) load, had a 490 mile (788km) range excess. To meet the long-range requirements of the Pacific War, in spring 1944 Vickers submitted a proposal to extend the Windsor's still air range with 4,000lb (1,814kg) of bombs to 4,000 miles (6,436km), which involved sacrificing most of the armour protection and some of the self-sealing material from the fuel tanks; the company stated that this version could be delivered from the start of Windsor production.

In April 1944 it was expected that Windsor production should begin in mid-1945 and during 1946 work up to a peak of forty per month. It was hoped that by mid-1947 thirty squadrons would be equipped with the type, mostly for operations in the Japanese theatre, but VCAS doubted, with its present armament, that the bomber would be suitable for that arena. The Windsor's ever-increasing weight brought proposals to fit Griffon engines, but these would require considerable redesign and were not adopted. Pierson's first brochure for a Griffon Windsor was completed in December 1944. Four 2,070bhp (1,544kW) Griffons (with the barbette guns) offered a maximum 382mph (615km/h) at 23,000ft (7,010m), sea level rate of climb at maximum loaded weight (79,000lb [35,834kg]) was 1,380ft/min (421m/min), service ceiling 30,000ft (9,144m) and the maximum bomb load was 12,000lb (5,443kg). An alternative Bristol Centaurus installation took the weight to 81,400lb (36,923kg) but reduced the ceiling to 27,000ft (8,230m).

The defensive armament problem, together with several other delays, meant that by the end of the war the type was not offering a sufficient advance for production to proceed. In November 1944 the order for 300 machines was cut to 100, and later to just 40. Then on 17th November 1945, at a Ministry production meeting, the surviving B Mk.Is were cancelled. On 23rd November Vickers was told that 'the manufacture of Windsor aircraft should cease immediately'. At this point NN670 was almost complete and NN673 well advanced and both were eventually reduced to produce.

The Windsor was originally designed as a replacement for the obsolescent Wellington and was to be an aircraft that could take its place in the first line alongside the Lancaster and Halifax; its development life would also extend well beyond either of these types. As originally conceived the Windsor was a fast, lightly-armed and comparatively heavily armoured night bomber which was to carry a moderate load of 4,000lb (1,814kg) at a maximum cruise speed of 330mph (531km/h) but, when it became clear that it would be needed for the Pacific, the debate centred on just how suitable it might be. In its initial stages the type was found to be not sufficiently in advance of the Lancaster IV in range or general performance to justify the Ministry's plans to employ it actively in the war against Japan; it was also thought undesirable to introduce a new type in this theatre until it had been fully tried out in the UK.

Interest in the Windsor had gradually waned, Vickers became increasingly involved in the commercial aviation field and it was to be the Lincoln which entered production to serve the post-war RAF. The RAF also evaluated two American bombers, the Boeing B-29 Superfortress and the Consolidated B-32 Dominator, and at one point it was keen to have the B-29. In fact there were proposals to build the B-29 in Britain but this never happened. The RAF had to settle with the Lincoln as its main post-war heavy bomber until examples of the B-50 Washington, an upgrade of the B-29, were acquired in 1951.

Vickers Windsor Development

In January 1945 Rex Pierson completed a brochure for a Windsor powered by four Rolls-Royce Clyde RCl.1.AC turboprop engines and fitted with four main undercarriage legs of a six-wheel bogie type then in the course of development. Visibly the airframe was unchanged, with a Windsor prototype nose, and only the engine nacelles had been altered; the rear nacelle guns were also retained. Cruise speed was estimated to be 390mph (628km/h) at 20,000ft (6,096m), sea level rate of climb 3,050ft/min (930m/min), time to 30,000ft (9,144m) 17.0 minutes and service ceiling 37,000ft (11,278m). A maximum 3,580gal (16,278lit) of internal fuel would have been carried and the range was 2,415 miles (3,886km). The Clyde turboprop, an example of a new concept of a jet engine and a propeller joined together, offered a combined 3,020bhp (2,252kW) and 1,225lb (5.4kN) thrust at sea level and 3,310bhp (2,468kW) and 738lb (3.3kN) for maximum speed and climb. Contra-rotating propellers would have been fitted if they were available.

The extra power from the Clyde would have been very beneficial to the bomber, which was designated Type 601 Windsor B Mk.2. In view of the attractive performance offered by the engine MAP informed Vickers on 27th February 1945 that it had been decided to fit NN673 with the new powerplants and asked that design work should proceed as soon as possible. Two more production Windsors were to be similarly converted (the same letter also stated that the idea of fitting the Griffon had been abandoned). Pierson replied that NN673 should be flying with Merlins by January 1946, but added that Rolls-Royce had reported that Clyde units would not be available until April 1946. By June 1945 this version had been given the revised 'ideal' nose with the twin 0.5in (12.7mm) turret, but the conversion and the whole project was cancelled on 16th January 1946.

Giant Bombers

In 1937 Vickers produced a scheme for an aircraft of 180,000lb (81,648kg) all-up-weight and fitted with wings 7ft (2.1m) deep which carried all of its load in the wings. It was primarily intended to be a passenger carrier operating at 'normal' altitudes but a bomber variant was also shown. By July 1940 the scheme had become a high-altitude aircraft which had wings of normal depth with the bomb load transferred to the fuselage, and in November the proposals were submitted to Lord Beaverbrook. The first descriptive brochure was completed in January 1941 and forwarded to MAP and other officials.

Vickers Long-Range High-Altitude Bomber

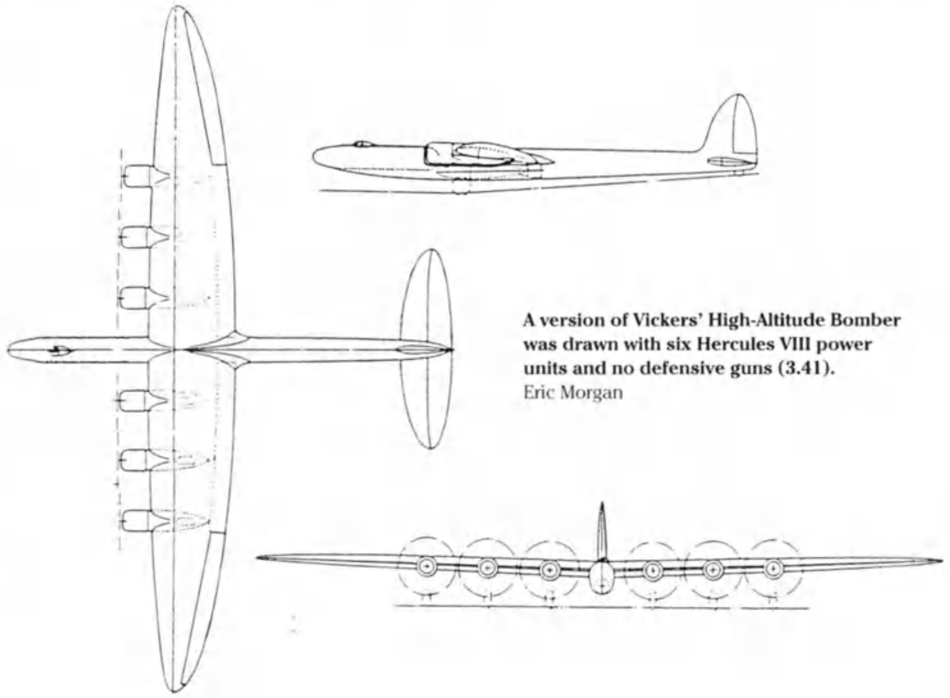
Intended to undertake stratospheric bombing, this aircraft was expected to carry just one heavy bomb weighing 10 tons (22,400lb/10,161kg). Barnes Wallis of Vickers had realised that a single very heavy bomb could prove devastatingly destructive when dropped accurately but, as has been well documented, it took a great deal of effort to bring his ideas to fruition (in the form of the 6 ton [6,096kg] 'Tallboy' and 10 ton 'Grand Slam' bombs). In the event the Lancaster was adapted to carry these weapons but in the concept's early days it was thought that no current type would be capable of lifting them high and far enough to be effective. Consequently Wallis and Vickers had conceived this huge aeroplane to deliver the weapon; some accounts state that Wallis called it his 'Victory Bomber'.

It was intended to climb to its cruising height in the vicinity of its home base where the existing defence facilities and guns would be available; consequently the bomber's own defence was limited to a four-gun rear turret remotely controlled from the pressure cabin. Five crew were housed in this cabin, which formed the front portion of the fuselage, and the air pressure was maintained at a value corresponding to 10,000ft (3,048m) altitude by a blower driven off one of the engines (six Merlin RM.6.SM), which was triplicated for safety. At a take-off weight of 104,000lb (47,174kg), including the single bomb plus 4,020gal (18,279lit) of fuel, the aircraft would cruise at 40,000ft (12,192m) at a mean speed of 306mph (492km/h) on the outward trip and 350mph (563km/h) on return. At this weight the maximum rate of climb was 1,200ft/min (366m/min) at 10,750ft (3,277m), time to 35,000ft (10,668m) 37 minutes and radius of action 1,800 miles (2,896km) (that is, a range of 3,600 miles [5,792km]).

On 9th January Beaverbrook wrote to Vickers to suggest that, subject to certain high-altitude work taking preference, the company should continue its research into a 50 ton (50,803kg) six-engine bomber. On the 30th Sir Henry Tizard visited Weybridge to discuss Vickers' design programme and on 4th February W S Farren, DTD, met Wallis and Pierson to see an outline of their scheme. On the 9th Tizard and DGRD agreed that Vickers should be given an order and in March Farren proposed the allocation of a contract to allow the building of prototypes on a special step-by-step basis. Two machines were planned with the work probably to be undertaken in stages – 1 project design, 2 commencement of detailing in the Main Drawing Office and 3 release of drawings to the Experimental Shop for manufacture and assembly; Vickers would not be permitted to go on to the next stage without authorisation from the Ministry. Farren added that it must not interfere with work of higher priority and, although in favour of the project, he was doubtful about the big bomb. Evidence then being collected on the damage to towns and factories from bombing raids did not support the concept beyond a size of 4,000lb (1,814kg).

Wallis pushed hard for his bomb and bomber. His objective was to produce a high velocity bomb of special streamlined shape

Wind tunnel model of the 'production' Windsor.
Eric Morgan



A version of Vickers' High-Altitude Bomber was drawn with six Hercules VIII power units and no defensive guns (3.41).
Eric Morgan

and fineness ratio which could hit its target with great accuracy. In addition, because it was dropped from a great height, the substantial kinetic energy that would be generated at impact should produce a deep penetration. Wallis had calculated that a 16,000lb (7,258kg) HV bomb with a 9,000lb (4,082kg) explosive charge, when released from an altitude of 40,000ft (12,192m), would reach at impact the supersonic velocity of 1,400ft/sec (427m/sec), and give a penetration in sandy soil of approximately 100ft (30.5m).

On 20th May, in a letter to Tizard, Wallis had assumed that the opposition to the 50 ton bomber was based on 'the reluctance of the Air Staff to order anything in the nature of a special purpose machine', along with the feeling that the its development period would be prohibitively long. Wallis felt that while the Air Staff's preference for all-purpose bombers up to the present time was unquestionably right, it was this policy which made the production time for a large bomber so great. This was due to the detail design and manufacture of the multifarious installations taking longer than that for the design and construction of the airframe itself, but Wallis thought that confining the design to one bomb with a single electrical circuit should reduce the development period by many months. As laid down the aircraft would involve as little new design as possible. The engine installation was six Wellington V units (with provision for alternatives such as four Centaurus), the undercarriages were the same as the Warwick but four would be used instead of two, the pressure cabin could be adapted from the Warwick or Wellington V and the wing followed almost exactly that of the high-altitude Warwick III; there was little 'novelty' except in the tail unit.

Next day Tizard replied saying that 'the Air Staff has no interest in a specialised big bomber solely designed to carry one big bomb and your view that the single purpose bomber offers a high probability of winning the war is not accepted .... but I may say that I entirely agree with it. I would be far more interested in the development of the big bomber if there was real elasticity in its use and [if] you told me .... that you hoped to design it so that it could provide either for taking one large single bomb or for taking a very heavy total weight of smaller bombs. Please confirm this – its makes a great deal of difference to my interest in your proposals.'

Wallis had also put together a large report called 'A Note on a Method for Attacking the Axis Powers' which examined every aspect of bombs and bombing very closely, and his theories for large bombs. On 23rd September Dr David Pye, DSR, informed Wallis that the document had been carefully reviewed by MAP in consultation with the Air Staff and it had been decided that no development work should be undertaken at the present time. On the same day DTD told Vickers that at present no development was to be undertaken on the large bomb and it was not proposed to proceed with the large bomber; the Minister had declared that in the current circumstances it was not justified.

However, Vickers kept the research ticking over and in January 1942 completed a brochure which recorded all of the latest work on performance and weight estimation. The aircraft was now designed to carry 32,000lb (14,515kg) of bombs over 2,000 miles (3,218km) or 16,000lb (7,258kg) over 4,000 miles (6,436km), and the ceilings over the target would be 43,500ft (13,259m) and 45,300ft (13,807m) respectively; Tizard's wish for alternative loads had also been addressed. Cruise speeds out were 272mph (438km/h) and 291mph (468km/h) respectively and 338mph (544km/h) and 334mph (537km/h) on the return journey while the ceiling on return would be 50,750ft (15,469m). Six Merlin 60s were still used with the rated height on 'S' blower increased from 30,000ft (9,144m) to 37,000ft (11,278m). It was thought that the only enemy aircraft likely to be encountered were fighters with forward-firing guns and so any attack would be expected from the rear hemisphere, thus the defence was still just a tail turret but this now had two 0.5in (12.7mm) machine guns and its own pressurized cell for the gunner.

Directly after the completion of this revision Vickers received notification from MAP, in the form of an official letter dated 9th January 1942, that it should stop all work on the six-engine heavy bomber project. Wallis' 'Victory Bomber' was finished but he persisted with his big bombs, which were eventually realised with 'Tallboy' and 'Grand Slam' and also the famous bouncing bomb used by the Dambusters in May 1943.

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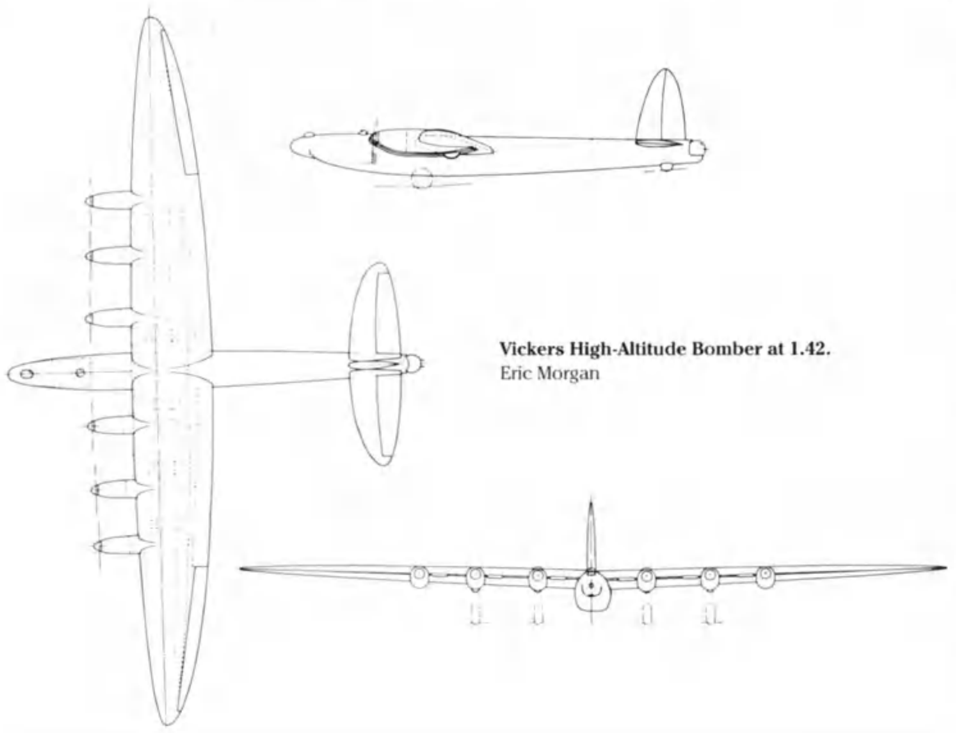


Vickers High-Altitude Bomber at 1.42. Eric Morgan

Despite these events, the idea of a very large bomber would not pass. Later in the year some new requirements appeared, but this time with a rather more modest cruise ceiling. As expected they generated much interest from Vickers who put together a complete set of designs, but other companies were also now involved.

In August 1942 the Air Staff passed its draft operational requirements to MAP and, as a result, Linnell, CRD, held a meeting on 25th September with the Air Staff and leading designers from the industry. The requirements included an operational range of 2,500 miles (4,023km) with at least a 15 ton (15,241kg) bomb load and preferably 20 tons (20,321kg), cruise would be about 300mph (483km/h) at a normal operating height of 20,000ft (6,096m), but with the ability to cruise at 30,000ft (9,144m) if necessary, and a defensive armament of six 20mm cannon was to be carried covering all angles. The general opinion of the industry was that these requirements were too ambitious and would result in an aircraft of 250,000lb (113,400kg) to 320,000lb (145,152kg) all-up-weight, which was regarded as too big a step up from current four-engined types.

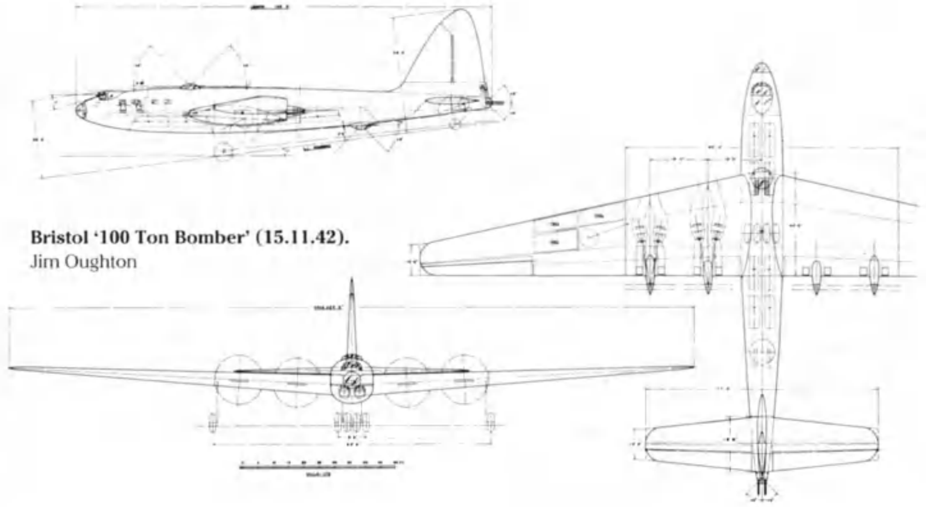
Wind tunnel model of the Vickers High-Altitude Bomber. Eric Morgan

Nevertheless, the concept became known as the '75 Ton Bomber' and on 17th October Avro's R H Dalna wrote to Linnell saying 'I, along with [Roy] Chadwick [Avro's chief designer], have been thinking quite a lot about this big bomber problem and matters are getting sort of crystallised in our minds, but one cannot get away from the fact that it is quite a big lot and a long job. Nevertheless, it is one which we are very anxious to do and I believe we could do it successfully and have a first class aeroplane. It might be a bit revolutionary, even though we are using and thinking around an entirely standard form of aircraft without anything fancy in it, and even without buried engines. The only semblance of anything fancy is the counter-rotating props, which we must have.'

By the end of December 1942 the 75 Ton Bomber was being considered as an undertaking of great importance; it was expected eventually to replace the Lancaster and all of the RAF's heavy bombers, and possibly also to form the basis of the UK's post-war civil aircraft. It was proposed that certain companies experienced in the design and manufacture of large aeroplanes should be asked for their rough views on the layout of such a type and in January 1943 five companies submitted a total of fifteen preliminary scheme designs.

Avro

Both of Avro's projects were conventional layouts based on the Lancaster, the smallest of 75 tons (76,205kg) and the larger 100 tons (101,606kg) and with a fuselage which the Ministry described as 'unnecessarily large'. The first had eight unnamed 2,000hp (1,491kW) conventional tractor engines, the second ten, all in individual nacelles. Their monocoque fuselages would have used stringers, heavy frames and longerons and the undercarriages had front and mid-ships wheels of equal diameter, although the brochure gave no details. Range for both was 2,500 miles (4,023km) and the maximum fuel loads were 57,300lb (25,991kg) and 78,800lb (35,744kg) respectively.



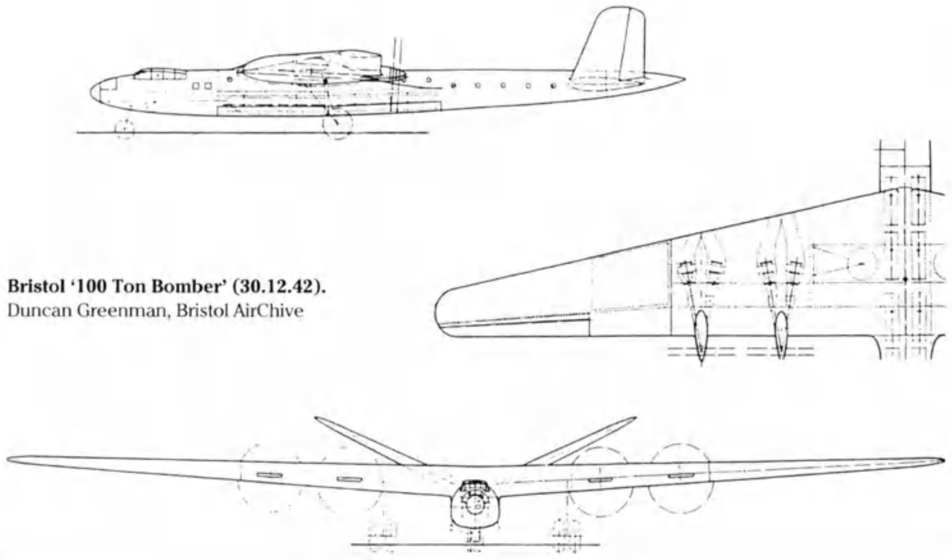
Bristol '100 Ton Bomber' (15.11.42). Jim Oughton

Bristol

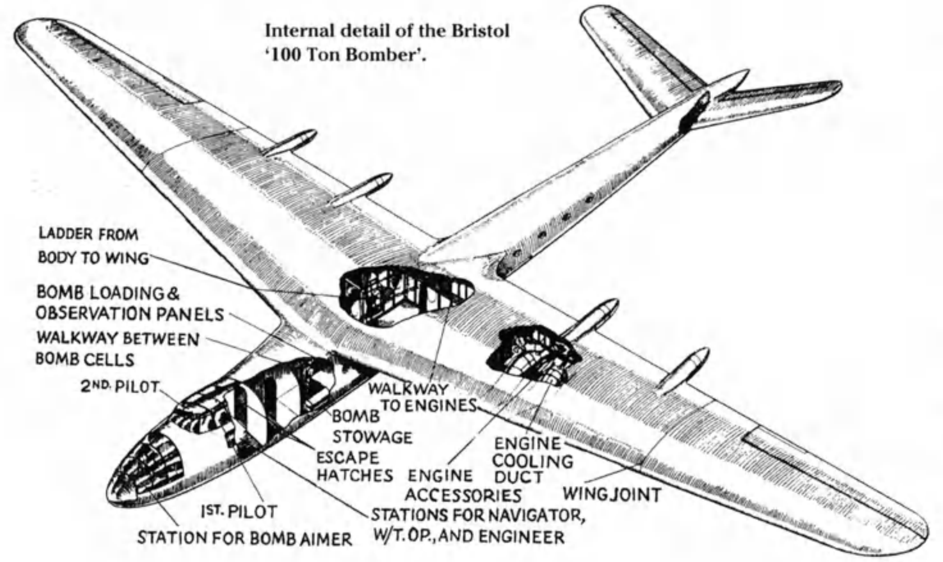
Bristol completed an initial '100 Ton Bomber' drawing on 15th November 1942; it featured eight Centaurus pusher engines coupled in pairs and driving contra-rotating propellers, a massive fin and three defensive gun turrets each with four guns, a forward dorsal, rearward ventral and a tail turret. The undercarriage had four main tyres under the fuselage, another under each wing and a smaller tailwheel, and the bombs were housed in the fuselage; span was 225ft 0in (68.6m) and length 136ft 6in (41.6m). When submitted in January 1943 this project had been refined with a sleeker fuselage, apparently no defensive guns, a tricycle undercarriage with twin tyres on both main and nose legs and a V-tail of 77ft 0in (23.5m) span had replaced the fin and rudder. The monocoque wings had no spars but were reinforced by thick skins and the bombs were still housed in the fuselage; maximum fuel load was 48,800lb (22,136kg). Rather less detail was supplied for Bristol's alternative '75 Ton Bomber' which had the same general layout but eight pusher Griffon 61s and four sets of propellers.

Handley Page

The first of three designs was a conventional layout powered by hypothetical 3,000bhp (2,237kW) 'developed Sabre' pusher engines (six Centaurus were an alternative). The wings had two spars, the engine nacelles were flush with the wing upper surface and there was a tricycle undercarriage with two wheels on the nose leg and a single wheel on



Bristol '100 Ton Bomber' (30.12.42). Duncan Greenman, Bristol AirChive



Internal detail of the Bristol '100 Ton Bomber'.

each main leg; 50,400lb (22,861kg) of fuel were carried. The two alternatives were described in Frederick Handley Page's covering letter as tailless developments, one with shaft drive engines and the other with Metro-Vick jets, and these readily adapted themselves to tier bomb stowage. To minimise mutual interference the small foreplane or 'rider-plane' was carried above the line of the mainplane. Engine choices were four Sabre pistons or eight Metropolitan-Vickers F.2 jets and the wings were swept back 22.5° and heavily tapered. The Sabre's wings had a D-nose and integral tanks and a tricycle undercarriage would have been used. The jet variant had a smaller wing, carried 5,000gal (22,735lit) of fuel and, because of the engine's lack of power, would have required an 'assisted take-off'. The assessors described it as the smallest, fastest and structurally the most efficient of any of these large bomber schemes, though it must be remembered that the quoted data was only an estimate.

Shorts

This submission was essentially three versions of the same design fitted with alternative engine installations, Centaurus, Sabre or the Bristol Orion piston; their respective fuel loads were 41,400lb (18,779kg), 69,550lb (31,548kg) and 69,380lb (31,471kg). In general this was an orthodox scaled-up version of the Stirling powered by six engines housed in separate nacelles and driving tractor propellers. There was a remotely-controlled rear turret and a normal undercarriage with a tailwheel although, compared to other designs, the main wheels had a quite narrow track and did not fully retract into the inboard nacelles.

Vickers

One of Vickers' first studies for a giant bomber appears to have been a drawing dated 9th November 1942 which showed an elliptical wing, six Centaurus tractor engines with turbo-blowers and a very tall fin. By December this had been refined with a longer fuselage and broader fin to become Scheme 'A', one of five alternative layouts ('A' to 'E') included in a slim brochure completed on 14th January 1943. The permanent fuel tankage on each was 5,200gal (23,644lit) and the data was quoted for a range of 2,500 miles (4,023km); all were powered by the Centaurus. A great variety of bomb loads was available and in all cases the maximum load was 56,000lb (25,402kg). On 'A' to 'D' this comprised two 12,000lb (5,443kg) and four 8,000lb (3,629kg), but other combinations of six heavy bombs were possible including a load of four 12,000lb. The smallest quoted bomb size was 2,000lb (907kg) and sixteen of these could be taken on board. Scheme 'E' however, could make up 56,000lb with four 12,000lb and two 4,000lb (1,814kg), and could also take twenty 2,000lb.

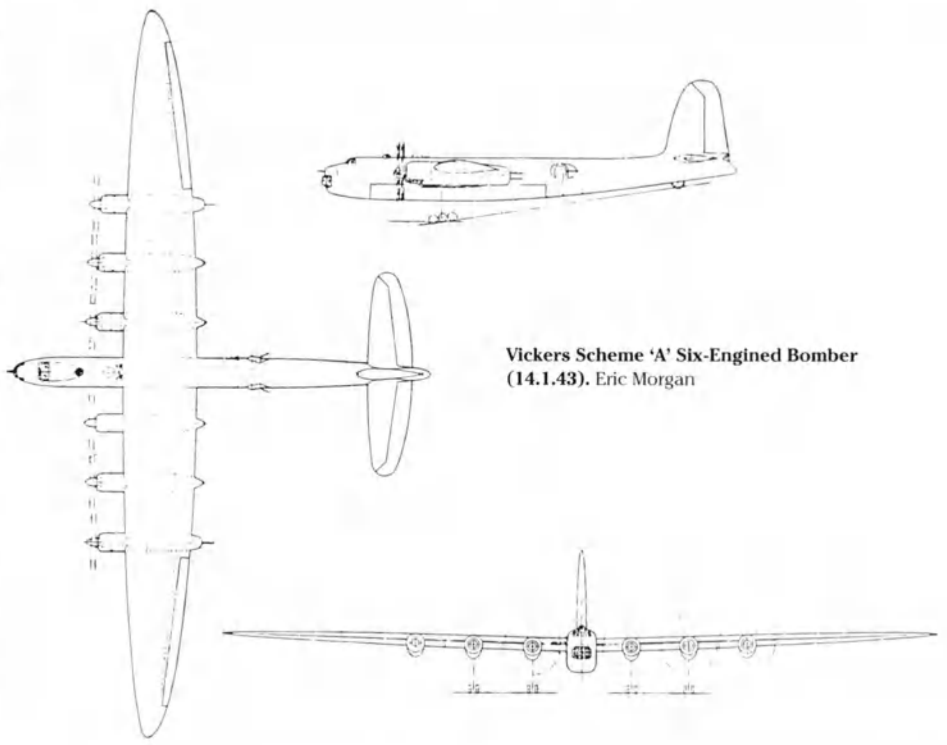
On the subject of rear defence, CofG considerations meant that it was only possible to install four or five 20mm cannon when the Air Ministry specification requested six. The tractor propellers in 'A' (and 'C') permitted the four rear-facing 20mm guns to be split into two well-separated pairs mounted in the tails of two of the engine nacelles and remotely controlled by a single stern gunner ('C' had an extra 20mm in the rear fuselage). Vickers stated that the degree of decentralisation that the rear nacelle guns achieved rendered the tail defence much less likely to be completely crippled by enemy fire than a single stern turret and suggested that this very important advantage was worth far more than its weight penalty of 4,000lb (1,814kg). It was noted that in England the design of a remote control and sighting system was well advanced while in America it was understood to have already reached a satisfactory practical conclusion.

The pusher Types 'B', 'D' and 'E' had, by necessity, their four 20mm grouped in a single stern turret, which Vickers felt could be put out of action by a single burst of enemy fire. It was also remarked that, to Vickers' knowledge, no turret housing four 20mm was yet in existence. The beam and forward defence, common to each layout, comprised respectively a single 20mm gun turret and gunner per side and a twin 0.5in (12.7mm) bow turret remotely controlled by the bomb-aimer.

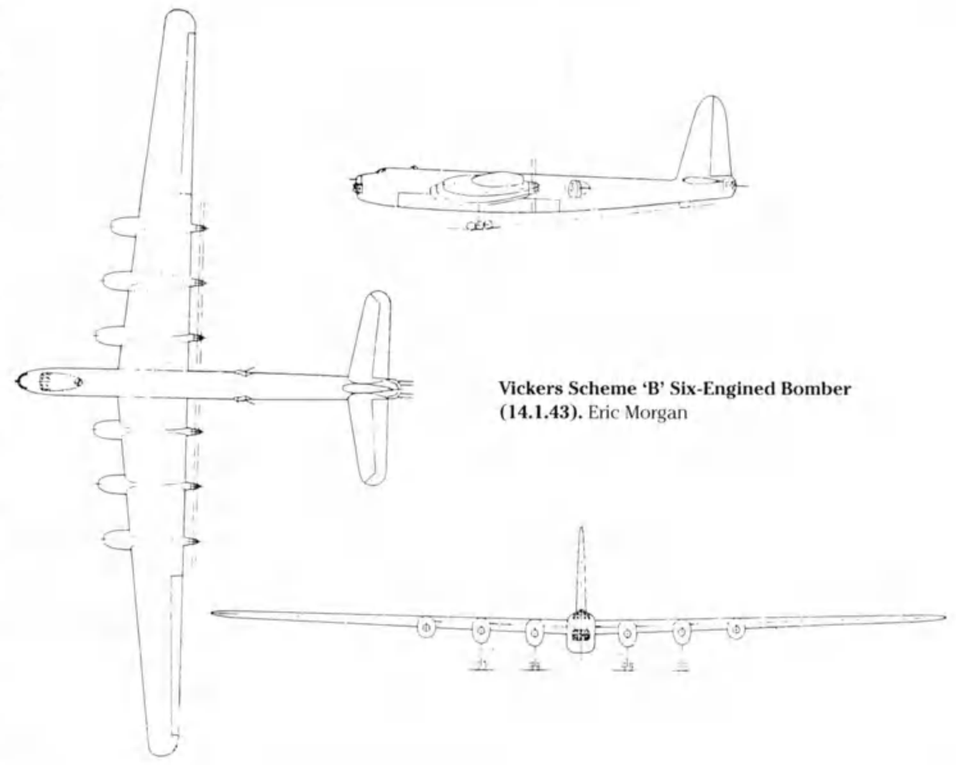
Types 'A' and 'B' both had a conventional tailplane and were designed to have a take-off weight of 168,000lb (76,205kg). To make a comparison to a neutral or downloaded tailplane, on 'C' and 'D' the wing was helped by the lifting foreplane, the difference being estimated at approximately 6% which added 10,000lb (4,536kg) to the disposable load and gave a take-off weight of 178,000lb (80,741kg) for the same effective wing loading as the conventional layouts; it would also reduce the landing speed. For the tailless Type 'E', the effect of the necessary washout of incidence progressively towards the tips was such that it limited the take-off weight to 174,000lb (78,926kg), in spite of the larger wing area which had been selected as the minimum required to enclose the engines.

Scheme 'A' had a tailplane, tractor engines in partly underslung nacelles and a tailwheel undercarriage with six wheels on each of four main gears; its wing was proportioned from the B.3/42 Windsor wing which was now under construction. Sea level rate of climb at full load would be 1,310ft/min (399m/min) and service ceiling 35,000ft (10,668m). Vickers felt this design offered a number of disadvantages, in particular difficulty in designing the controls in the tail owing to the presence of the slipstream; it would also be difficult to convert to jet propulsion because of changes in the CofG. 'B' was described as semi-conventional with a tailplane, pusher engines in nacelles mounted flush with the wing upper surface, six-wheel main gears and a tailwheel, but no fundamental departure from current design practice was expected. Here the full load sea level rate of climb would be 1,330ft/min (405m/min) and service ceiling 35,200ft (10,729m). Due to the absence of turbulent flow over the wing the pusher propellers were expected to result in a saving of drag over 'A'. Again a jet conversion could be difficult but here the CofG movement would be less.

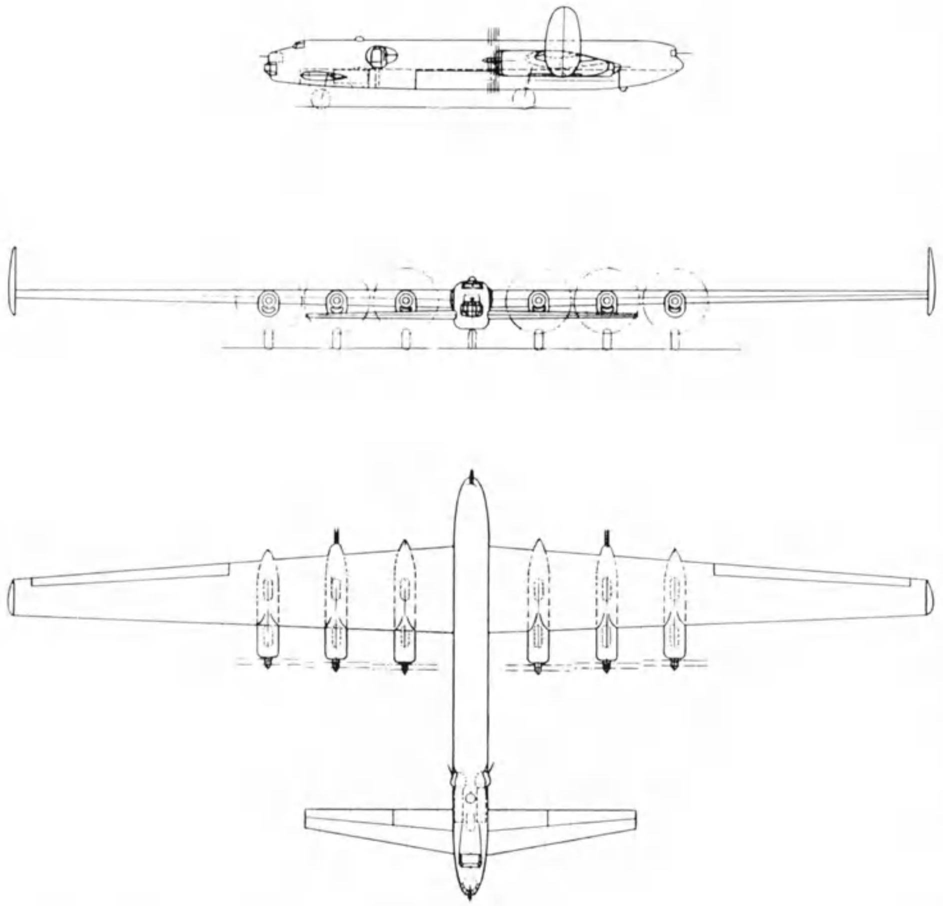
Scheme 'C' was classed as experimental and had a foreplane, tip fins on the main wings, tractor engines and a tricycle undercarriage with six main legs, one per nacelle. When the brochure was submitted this layout was being subjected to some wind tunnel tests which appeared likely to lead to a satisfactory solution to the problems of longitudinal and directional stability and control, though some wing sweepback might have to be introduced. To help the CofG, 25% of the fuel was carried in the foreplane and front fuselage. Sea level rate of climb was quoted as 1,280ft/min (390m/min) and service ceiling 34,800ft (10,607m). With such a novel design, it was considered essential to make use of a roughly ¼-scale flying model to confirm the aerodynamic behaviour. This would proceed in parallel with the design of the full prototype and would only need two engines and use the simplest and quickest wood or metal construction possible (manufactured by 'experts such as de Havillands').



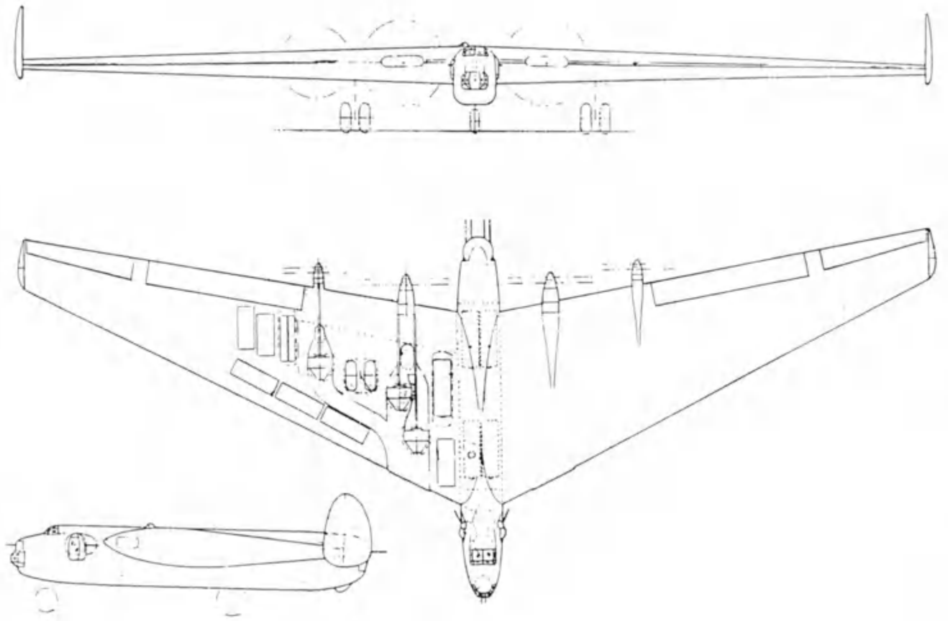
Vickers Scheme 'A' Six-Engined Bomber (14.1.43). Eric Morgan



Vickers Scheme 'B' Six-Engined Bomber (14.1.43). Eric Morgan



Vickers Scheme 'C' Six-Engined Bomber (drawing 12.42). Eric Morgan

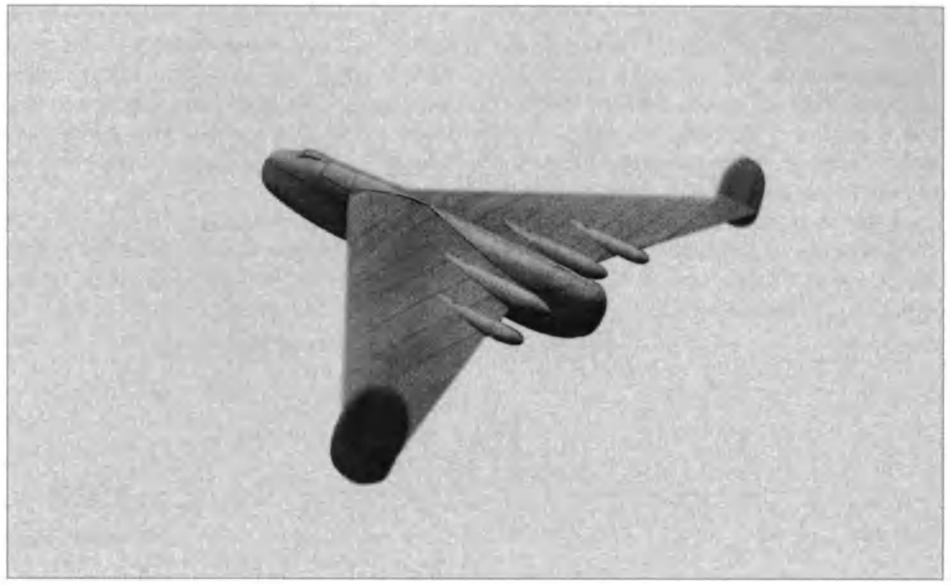


Vickers Scheme 'E' Six-Engined Bomber (drawing 20.12.42). Eric Morgan

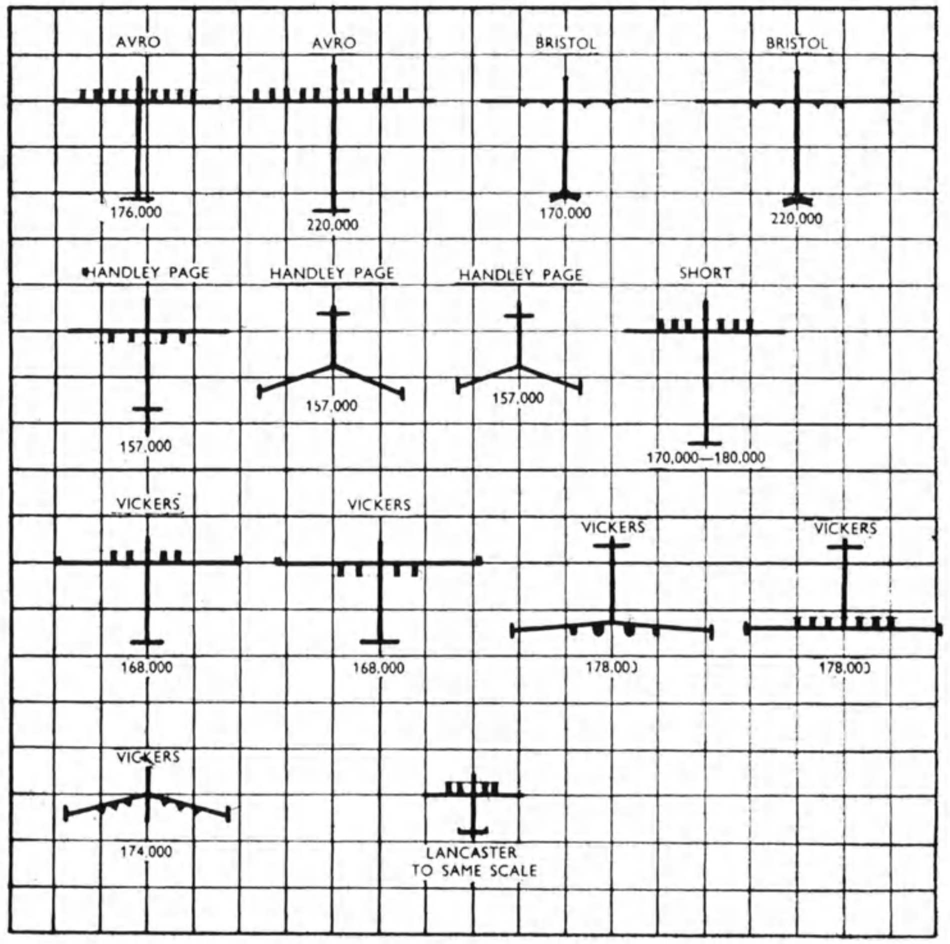
The absence of a tailplane meant that the engines were roughly in line with the fore and aft CofG positions, which made the layout eminently suitable for installing jets (in April 1943 Vickers drew a similar foreplane bomber which had six de Havilland jets in the wings). Flaps on the foreplane also helped to reduce the landing speed but one disadvantage, due to the large spanwise distribution of thrust necessitated by six separate piston engines, was a possible tendency to yaw should some of the engines be crippled.

Scheme 'D' was 'experimental' with a foreplane, pusher engines and a tricycle undercarriage. In order to reduce the maximum lateral displacement of the remaining thrust when two engines were dead, advantage had been taken with the pusher propeller arrangement to combine two engines in one nacelle. The drawing showed co-axial propellers with opposite rotation, each being driven separately by one engine through independent gearing, but Bristol had this matter under consideration and it was possible that they might advise combining the two engines to drive a pair of contra-rotating propellers through one set of gearing. Each outer nacelle housed a single engine driving a straight, direct shaft with a contra-rotating gearbox at the rear end. This design offered the take-off weight and landing speed advantages of 'C' and the drag reduction of 'B', but it would again suffer yawing if some engines were out; it also had the weaker rear defence. Its full load sea level rate of climb would be 1,280ft/min (390m/min) and service ceiling 34,800ft (10,607m).

Scheme 'E' was an experimental tailless design with pusher engines and a tricycle undercarriage with just two main gears. Its wings were swept back 15° and, to achieve longitudinal stability, they had been given appreciable washout towards to the tips. The wing depth was sufficient to enclose all six engines and there were ten fuel tanks, also all in the wings. Sea level rate of climb was 1,150ft/min (351m/min) and service ceiling 32,000ft (9,754m). Again such a novel design would need a flying model of about ¼-scale, built along the same lines as 'C', and it was thought that, due to the absence of a tail or foreplane, the design would suffer from a lack of damping in pitch which would be accentuated by an abnormally small longitudinal moment of inertia compared with the mean chord length. In addition, according to recently published reports, the permissible waviness for laminar flow was so small on such a large chord, as seen on most of this wing, as to be almost impossible to achieve in practice. The engine's cooling ducts were also very long and would present a considerable problem in air tightness; however, the absence of a tailplane was favourable for fitting jets but enclosing the power units in the wings might create problems in installing the intakes and jet pipes.



Wind tunnel model of Vickers Scheme 'E'.
Eric Morgan



No drawings are known to exist for several of the '75 Ton' and '100 Ton' Bomber designs produced in January 1943, but this sketch illustrates their configurations.

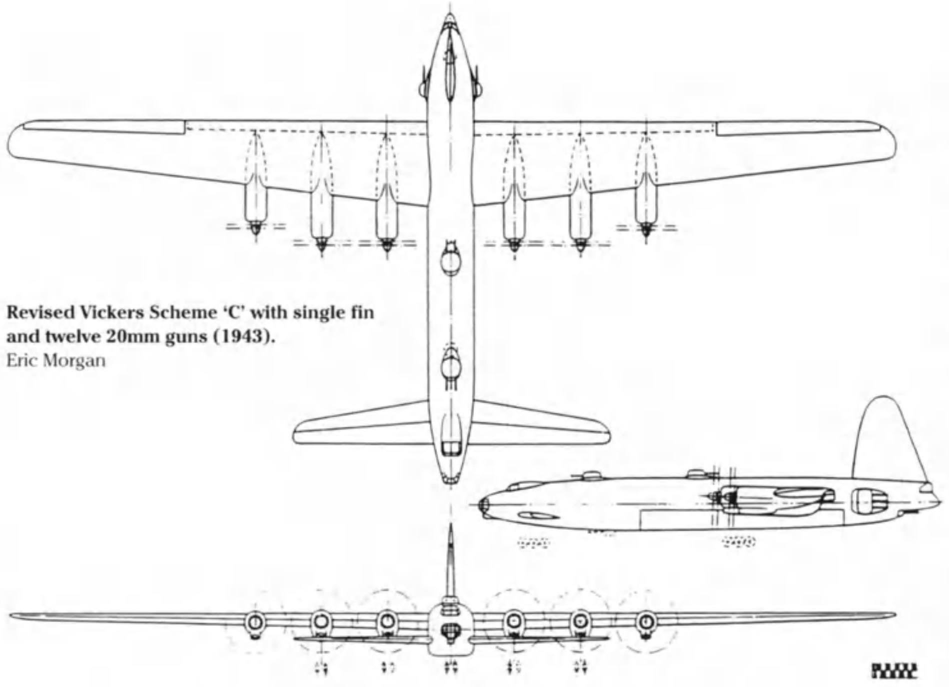
In his covering letter for the brochure Rex Pierson declared that, in his opinion, the most attractive design was 'C', and he did not favour the tailless 'E'.

None of these designs met the requirements entirely but, in their present form, N E Rowe, DTD, favoured Bristol's heavier layout. However it did present certain special problems, such as the installation and maintenance of buried engines, while the V-tail was also expected to give inadequate lateral stability which prompted suggestions for a return to a conventional tail. Rowe had deduced that the designs could not approach the requirements within a limiting weight of 75 tons (168,000lb/76,205kg), or with six engines which made a switch to eight essential (as suggested in the Bristol study). On 11th February 1943 Rowe stated that 'Bristol have made a thoughtful contribution showing buried engines and a particularly neat method for coupling pairs of engines. The fundamental features of their design spring from the decision to bury the Centaurus engines in the wing. This forced them to a comparatively low wing loading which is basically uneconomical. Nevertheless, theirs is the most promising approach to the problem and probably is near the optimum within the choice of engines available.'

Rowe continued 'it was generally agreed that the all-wing layout is still experimental. We could not back ourselves in the present state of knowledge to develop it successfully in a reasonable time. The tail-first aircraft, according to RAE analysis, offers little or no advantage since the fuselage is not suppressed, hence that source of drag is not saved. Thus we are compelled to retain a conventional or near conventional aerodynamic form.' None of the tailless designs was actually a pure flying-wing and, consequently, they all fell well short of what might be possible. All of the Vickers projects had geodetic structures which gave percentage structure weights of around 26%, which was below anything built previously and, if achieved, would put these designs well ahead of any other; in addition their multi-wheel multi-leg undercarriages were intended to keep down the wheel size. The buried engines with common duct on the Vickers Scheme 'E', however, was not thought to be a satisfactory arrangement.

The Bristol design was indeed considered attractive and by February 1943 had become involved with Lord Brabazon's Committee on post-war civil aviation. After discussions to decide whether it should be designed primarily as a bomber or primarily as a transport, it was set on one side to make way for a civil version which became the Brabazon airliner, complete with a conventional and very large single fin. This was flown in September 1949 but remained a prototype, although Bristol later worked on another military variant. Both of the Vickers foreplane designs, 'C' and 'D', appeared to be unstable both longitudinally and laterally; sweepback would help but that would bring a major change to the layout. Type 'C' as submitted was felt to have a quite inadequate defensive armament and even its bomb load and range characteristics were disappointing. This design was later revised with a single fin and rearranged turrets that housed a total of twelve 20mm guns, six of which could be fired astern, and it was re-assessed by Rowe.

Initially, the objective of these requirements had been to find an aircraft to replace the present heavy bombers and which could be in production in the minimum of time, but as the assessments and study continued it became clear that an aircraft of such size could not enter production in less than five years. It would also be difficult for the type to achieve the proper balance between range, bomb load and defensive armament; long range was an essential feature but adequate defensive armament and an economic bomb load could only be obtained at the expense of range. Again the ever growing success of the Lancaster eventually removed the need for such large bombers. Although none of these projects were ever built as bombers, they represent quite probably the most ambitious collection of design studies ever attempted by the British aircraft industry to that date; the number of design man-hours spent on them must have been prodigious.

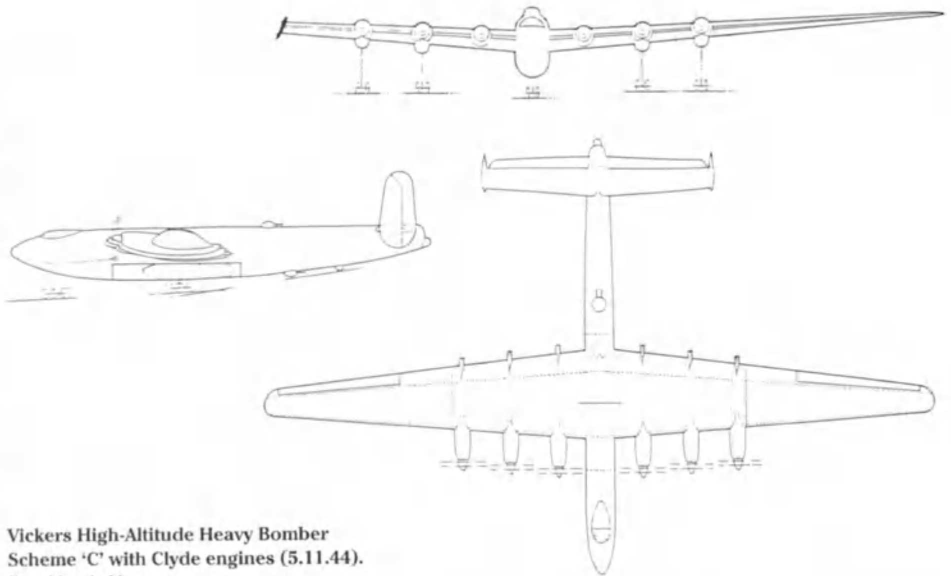


Revised Vickers Scheme 'C' with single fin and twelve 20mm guns (1943). Eric Morgan

Vickers High-Altitude Heavy Bomber

After the end of 'official' research, Vickers continued studies into four, six and eight-engine bombers well into the autumn of 1944, and these culminated in a set of high-altitude bomber projects powered by Rolls-Royce RB.39 Clyde turboprops which were described in a small brochure dated November 1944. The drawing reproduced here, Scheme 'C' dated 5th November, shows a project with twin fins, six wheels on the nose gear and on each of the four main gears, and 20mm dorsal and ventral turrets for 'all round defence'. Its span was 185 ft 0in (56.4m), length 113ft 3in (34.5m) and gross wing area 2,860ft² (266.0m²) and the fuselage bomb bay would house a single 'Tallboy' or 'Grand Slam' bomb. No weight or performance data is available but the design had a pressure cabin. A second version, Scheme 'B' dated 8th November, showed the same project but had a large single central fin, tail guns and no turrets. Here the span was 182ft 0in (55.5m), length 112ft 9in (34.4m) and wing area 2,750ft² (255.6m²). Scheme 'A' was smaller at 175ft (53.3m) span while another variant, dated 9th November, retained the twin fins and original turrets but used four 'enlarged engines' based on the Clyde.

None of the giant bombers described here was ever close to being built but the work at Bristol did help in the design of another giant aeroplane, the Brabazon trans-Atlantic airliner first flown on 4th September 1949. High Duty Alloys



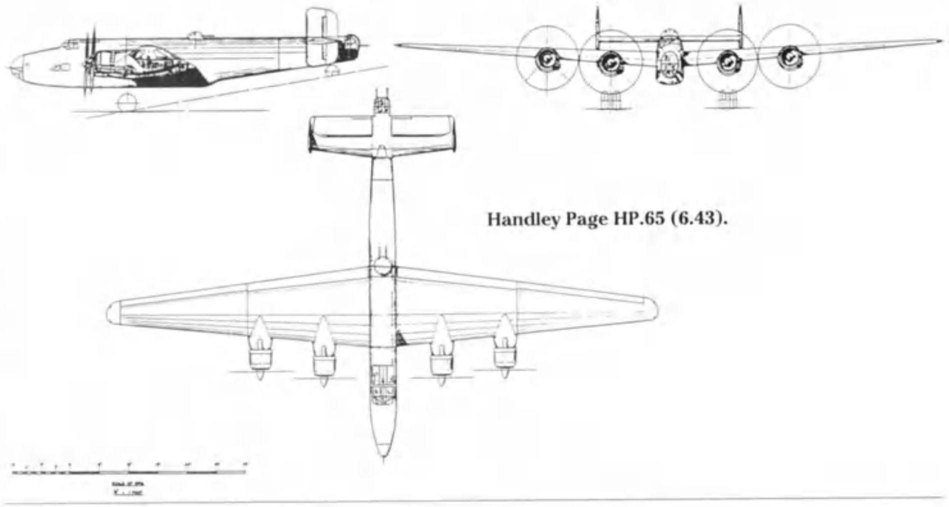
Vickers High-Altitude Heavy Bomber Scheme 'C' with Clyde engines (5.11.44). Brooklands Museum

Handley Page 'Super Halifax'

Handley Page HP.65

In June 1943 proposals were made by Handley Page to develop the Halifax into a much more capable high-speed heavy bomber called the HP.65 'Super Halifax'. The brochure made no reference to any specification but the project makes an interesting companion and comparison to the Avro Lincoln (below) and it was expected to show a greater bomb load and capacity, increased range and cruise speed and a greater operational height over any existing type. The aircraft had a new low-drag high aspect ratio wing with an extended span of 113ft (34.4m), new Hercules 38 turbo-supercharged engines and a new undercarriage, all fitted to a standard Halifax III fuselage and tail unit but with the bomb bay rearranged to take a maximum size of 12,000lb (5,443kg) with the doors closed. Further development would see the fuselage replaced by a pressurised alternative of circular cross-section, developed from the fuselage of the company's new transport project, but retaining the Halifax's fuselage in the first instance would help get the prototype airborne many months earlier.

It was of the utmost importance that the Halifax's altitude performance should be improved. The type's existing two-spar wing gave spanwise seams that generated drag so the HP.65 was proposed to have the smoothest possible external form and lowest structural weight. The main stress-carrying portion of the wing section would be made of heavy-gauge skin to give a very smooth surface free from any appreciable waviness and the skin stiffeners were arranged so that, as far as possible, all the riveted seams would lie in a chordwise direction. The new single main spar was placed at 40% of the chord back from the leading edge and the entire skin contributed to the torsional strength of the wing. All of the internal fuel (2,500gal [11,367lit]) was carried in integral tanks built into the main wing and all external projections on the engine nacelles were suppressed – the duct entries were in the leading edge while the oil cooler, carburettor, air cleaner and intercooler were all housed within the nacelle fairing or the wing. There were two twin 0.5in (12.7mm) defensive turrets plus the Halifax's standard nose gun. A maximum operational altitude of 30,500ft (9,296m) was quoted at 66,500lb (30,164kg) weight while cruise speed would be 285mph (459km/h) and range 3,710 miles (5,969km).



Handley Page HP.65 (6.43).

The Ministry compared the HP.65 to the Lancaster Mk.IV (later the Lincoln) but felt that the company's estimates for drag and weight were optimistic. On 1st October J E Serby noted that the new wing would create a vast amount of design work and so it was difficult to see the spring 1945 production date being met. The top speed quoted by Handley Page, 350mph (563km/h) at 27,000ft (8,230m), was revised by RDT to 326mph (525km/h) at 26,000ft (7,925m), with the maximum operational height 27,000ft.

Handley Page HP.66

In late October 1943 N E Rowe met Handley Page representatives and suggested that the HP.65 should be abandoned for a simpler redesign which retained the Halifax's two-spar wing but with a new section attached. In mid-November the project was presented as the HP.66 and showed the old wing extended to 113ft (34.4m), which would save about 50% in design time over the HP.65 at the expense of a small loss in speed. This increase in span, the existing centre and outer planes being fitted with a new intermediate section and additional strengthening, took the wing to its limit in terms of retaining the greater part of the existing jigs and parts. Meanwhile the HP.65's 1,162ft^2 (108.1m^2) wing area had been found to be inadequate for good take-off performance and so it was proposed to increase this to 1,408ft^2 (130.9m^2).

On 2nd December 1943 a contract was allocated to proceed with this aircraft and in February 1944 specification B.27/43 was raised to cover the project. Fitted with Hercules 100 engines it was proposed to call the type the Hastings B Mk.1, while a version with turbo-blower exhausts would become the HP.69 Hastings Mk.II. Three prototypes were also ordered during February, SR650, SR654 and SR657, (two Hastings Mk.I and one Mk.II) and a fourth (SX553) was added in early April. A back-up arrangement was available to fit Merlin 65s in cylindrical nacelles and these interchangeable units with four-blade airscrews were tested on DG296, a Halifax Mk.II, and LV795, a Mk.III; they were standard powerplants already adopted for the Avro Lincoln and Vickers Windsor. Twin 0.5in (12.7mm) machine guns would be housed in upper, tail and nose turrets and remotely-controlled 20mm cannon would be fitted in the outer engine nacelles.

The all-up-weight was 70,000lb (31,752kg), a maximum load of 14,000lb (6,350kg) of bombs could be carried and the top speed was 321mph (516km/h) at 27,050ft (8,245m); maximum internal fuel was 1,802gal (8,194lit). It was hoped that the prototypes would be followed by two hundred production machines to be manufactured at Radlett from May 1945, after the completion of the Halifax run. However, the turbo-blower HP.69 was shelved in April 1944 when priority had to be given to two hundred Halifax A.Mk.IX transports needed for the European invasion; it was also clear that Bristol would be unable to take on the engine installation work. The HP.66 prototypes were retained but after VJ-Day these too were no longer required and so were abandoned and replaced by the HP.67 transport, which was also given the name Hastings.

On 26th October 1943 Rowe, when reporting his meeting with Handley Page to discuss the new proposal, had written 'we treat it not as a new starting off place for the Halifax, but rather as a final development in which we would use conventional armament, as used in the Lancaster IV'. He added that 'I had hoped that [Frederick] Handley Page might be prepared to open up on a tailless design, possibly in preference to sinking more design effort into the Halifax; I sounded him out on this but he is clearly not ready to take a major step of this sort.' Three days later Saundby, CRD, added 'since we commenced to discuss the developed Halifax, Handley Page's ideas seem to have tended more and more to what would amount to a complete redesign. Although improvement in the Halifax as a bomber is desirable, it is fairly evident that by the time it can be ready the main requirements for bombers will be met by the Lancaster.'

Left and opposite page top: **Two views of Avro Lincoln B Mk.II RA638.**

Avro Lincoln

Avro 694

The development of the Lancaster was also taken to a stage at which the structural redesign was radical enough for the aircraft to deserve a new name, in this case Lincoln. In 1942 it was acknowledged that an improved Lancaster was needed and on 17th October Avro's R H Dalna wrote to Air Marshal Linnell, CRD, to suggest some ideas. He believed that 'we could have a replacement Lancaster, spliced into our production line, in a year's time. In this I am thinking about the Lancaster with either Sabres or Griffons with its speed pushed up by some 30 odd miles per hour (48km/h) from what it is at present, [while] maintaining the same bomb load and the same range. The great advantage of this would be, and I stress it as an interim measure, the retaining of a very large proportion of our detail tooling and even main assembly jigs'.

In fact the initial estimates showed a project with four Merlin RM.14.SMs and they indicated an all-up-weight of 70,000lb (31,752kg), top speed 346mph (557km/h) at 20,000ft (6,096m) and service ceiling 34,000ft (10,363m). The bomb load totalled 12,000lb (5,443kg) and the defensive armament comprised twin 0.5in (12.7mm) machine guns in nose and tail turrets and two 20mm cannon in a dorsal upper turret. This was initially known as the Lancaster B Mk.IV and Mk.V and structural alterations were made to the wing, fuselage and undercarriage to increase the type's offensive performance. Its introduction, along with the Vickers Windsor, was thoroughly considered by the Air Staff's Defence Committee who decided at the end of the year that these two types 'were the best that could be brought into service in time to affect the future course of the war'. They would supplement and eventually replace Bomber Command's Lancasters.

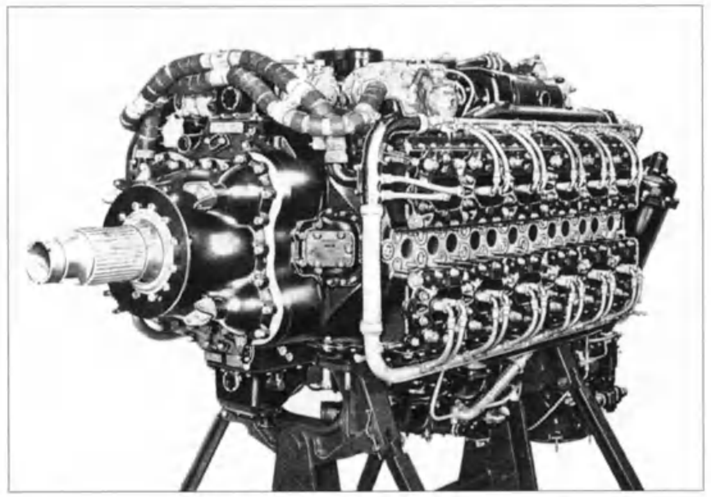
A prototype contract was placed in July 1943 and the first order for 162 production aeroplanes followed a month later. Production specifications for two versions were issued under B.14/43 to cover 'The Design and Construction of Lancaster B Mk.IV and Mk.V Bombers by the Parent Firm'. The operational requirements were essentially the same as the Lancaster B Mk.III's but with improved defensive armament and protection and Merlin 85 or 68 engines for the respective marks. However, one objective was to make the new type suitable for operations in the Pacific theatre as a contribution towards helping America defeat Japan, but this needed a much greater range and ceiling.

The new type resembled the Lancaster but there were many differences and it was realised that a new name would be more suitable; an old name meant an old aircraft and Avro wanted a new one, but Bomber Command preferred to retain Lancaster. In June 1944 Avro suggested Lincoln which J D Breakey, ACAS(TR), noted was 'very appropriate as it falls within the bomber category (i.e. a city) and is moreover the name of a city within the area in which Bomber Command operates their aircraft'. The company also offered Sandringham and Stafford but Lincoln was the most favoured and was officially adopted in August. The Avro 694 Lancaster IV and V became the Lincoln B Mk.I and B Mk.II respectively.

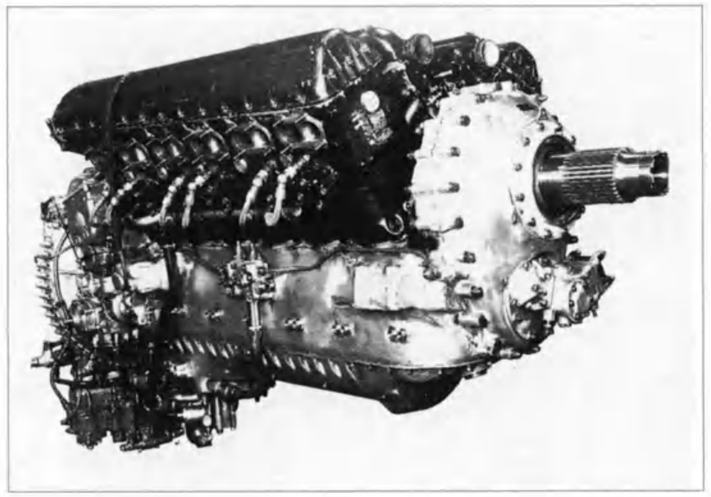
Bomber Command had been critical of the Lancaster bomb-aimer's prone position and so during July and August 1943 a modified nose was fitted to Lancaster ED371 which provided a seat, flat-glass panelling and a new turret with twin 0.5in (12.7mm) guns. Flight testing began in September 1943 and proved a success; visibility was much improved while the aircraft's top speed rose by 6mph (10km/h) and, consequently, a similar nose was adopted for the Lincoln. The Lincoln was rather bigger than the Lancaster both in span and length and there were changes to the bomb bay and defensive armament. It was intended that the larger wing would considerably extend the high altitude and cruise performance but it also meant that many hangars could not cope with the extra span, so side-tracking skates fitted around the undercarriage had to be used to 'slide' the machines into their hangars.

The Lincoln prototype PW925 first flew on 9th June 1944 but the urgency to get the type into service was diluted by events. In 1944 the well-established Lancaster seemed quite adequate for 1945 and it left no spare manufacturing capacity. As the situation in both Europe and the Pacific improved, the need for the new bomber receded and the priority for its production was reduced. When the war ended the need for so many bombers went with it and large numbers of Lincolns were cancelled. Nevertheless well over 500 were eventually built for the RAF, some operating throughout the 1950s, and other examples served in Argentina and Australia. There were also post-war proposals for a re-engined

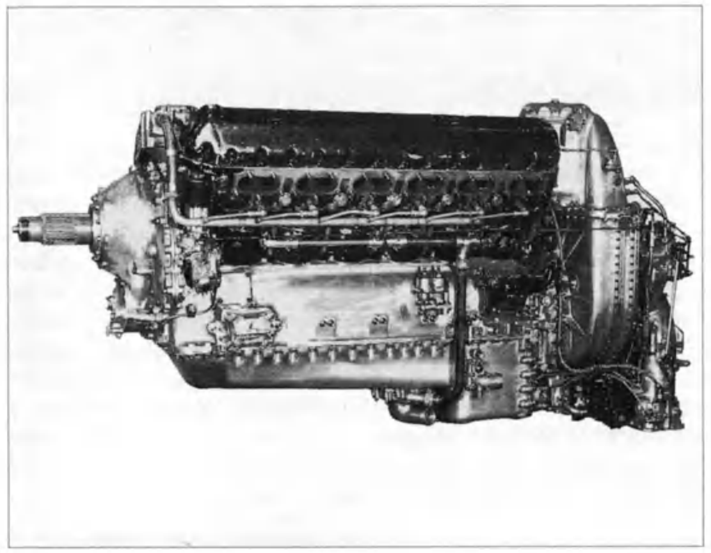
Wonderful view of the Heat Treatment Bay (formerly the 'Old Prop Shop') at High Duty Alloys Slough, taken in about 1937. Aluminium propeller blades and piston forgings wait to be heat-treated, an operation that will give them their optimum properties. HDA Forgings



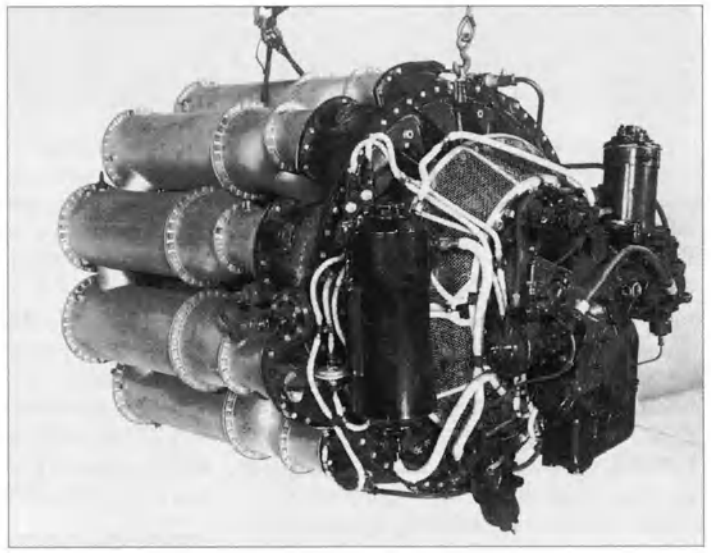
Top left: **Napier Sabre piston engine.** Rolls-Royce Heritage Trust



Top right: **Rolls-Royce Merlin XX piston engine.** Rolls-Royce Heritage Trust



Above left: **Rolls-Royce Griffon.** Rolls-Royce Heritage Trust



Above right: **Rolls-Royce Welland jet engine.** Rolls-Royce Heritage Trust

Lincoln II with Merlin 626s which it was hoped would get the bomber further into Russia. In fact this variant offered an increase in ceiling and performance but not range and so the project was dropped in February 1949.

This and the previous chapter have shown that the British aircraft industry undertook a massive amount of heavy bomber design during the period 1935 to 1945, which accurately reflected the desire for the RAF to possess a powerful striking force. By the close of the Second World War this force was fully operational and very effective.

Technological Advance

The design of the great majority of the aeroplanes described in this book was made possible by substantial advances in the technology of aircraft and engine design, so let us pause for a moment from the projects themselves to take a quick look at some of the progress that was made during this period. To begin however, the major re-equipping of the RAF and FAA would not have been possible without a huge expansion in the facilities and production capacity of the industry itself. Many new factories were built (mostly under the 'shadow' scheme where they came under the control of the individual aircraft companies) but these were supplemented by the production of aircraft and engines in quite a number of car factories. In addition, types like the Lancaster and Mosquito were built in Canada and Australia while the armed forces also received a great number of American types.

Moving on to engines, piston engine power at altitude had been much improved by the process of supercharging. As an aircraft ascends to higher altitudes the diminishing density of the aspirated air, combined with a reduction of the atmospheric pressure upon which aspiration depends, results in a smaller mass of air entering the cylinder; consequently the mass of fuel to be burned has to be reduced and with it the power of the engine. Supercharging employs a compressor (also called a 'blower') to increase the density of the air taken into the cylinders and it takes the form of an impeller (a wheel with a number of radial vanes formed on one face) turning inside a casing. When the impeller revolves at high speed, the air that enters is carried around between the vanes and then thrown outwards by centrifugal force, before escaping through peripheral outlets into a collecting chamber from which it passes to the engine. To keep the engine running at a constant speed at all heights, the supercharger required some form of variable speed drive and, as a result, two-speed superchargers were commonly fitted in which different gear ratios were used according to the altitude. Work on supercharging actually began as early as 1915 and its success was dependent on the ever-increasing quality of fuels to prevent detonation.

The power generated by the piston engine is used by the propeller or airscrew. The engine turns a shaft and the propeller is placed on the end or hub where, to pull the aeroplane forward, it is set at an angle (or pitch) to the plane of rotation; however, it is not possible to fix the blades at just one angle and get good results at all speeds. On early aircraft the blades did have a fixed pitch (a set angle) that was intended to form a compromise between good performance at high speed and good performance at low speed. However, the ever-increasing power, speed and performance of military engines and aircraft, particularly fighters like the Spitfire, needed something better. Fine pitch is best for take-off (that is, a small angle to the plane of rotation) and course pitch is best for high speeds (because the large angle will exert the maximum force to drive the aircraft forward).

The answer was the variable pitch propeller which altered the blade angle during flight, and also imposed much less strain on the engine while considerably improving the fuel economy. The simplest form was the two-pitch bracket propeller which had a fine pitch setting for take-off and climb and a course setting for level flight (both were pilot-operated), but the best solution was the constant speed unit. This had a small pump which, without any intervention of the pilot, adjusted the pitch of the propeller as the aircraft climbed or dived, so that the blades were always set at the correct angle whatever the speed selected by the pilot. Early in the war propellers were usually fitted with two or three blades but, with the increasing size of aero engines, it became necessary to fit four or even five blades to absorb all of the extra power. The biggest engines needed six blades which brought the introduction of the counter-rotating airscrew or contraprop, where two three-bladed propellers were mounted one behind the other and turned in opposite directions.

The materials used for blade manufacture were either metal or wood and Duralumin (aluminium alloy) blades were machined out of forgings, as were the aluminium pistons used in the engines themselves. Extra factory space had to be built for all of these components and an example was High Duty Alloys, whose factory at Slough was clearly going to be too small for wartime production. On 16th August 1939 HDA's 'shadow' factory at Redditch was opened and, following bomb damage to the forge at Slough, this new site became responsible for nearly all of the forged aero engine pistons produced in Britain during 1939-45, the final total reaching over 10 million.

There were numerous other developments in engine technology, such as water injection and sleeve valves. Engine development also demanded better materials and great progress was made in aluminium alloys, while the introduction of the jet brought with it the development of the nickel-chromium alloy 'Nimonic' which offered outstanding strength properties at very high temperatures. This alloy was to prove crucial in the successful operation of jets because it allowed them run for long periods without having to replace any parts – a luxury denied to the Germans whose jet engines consequently had a service life of just a few hours.

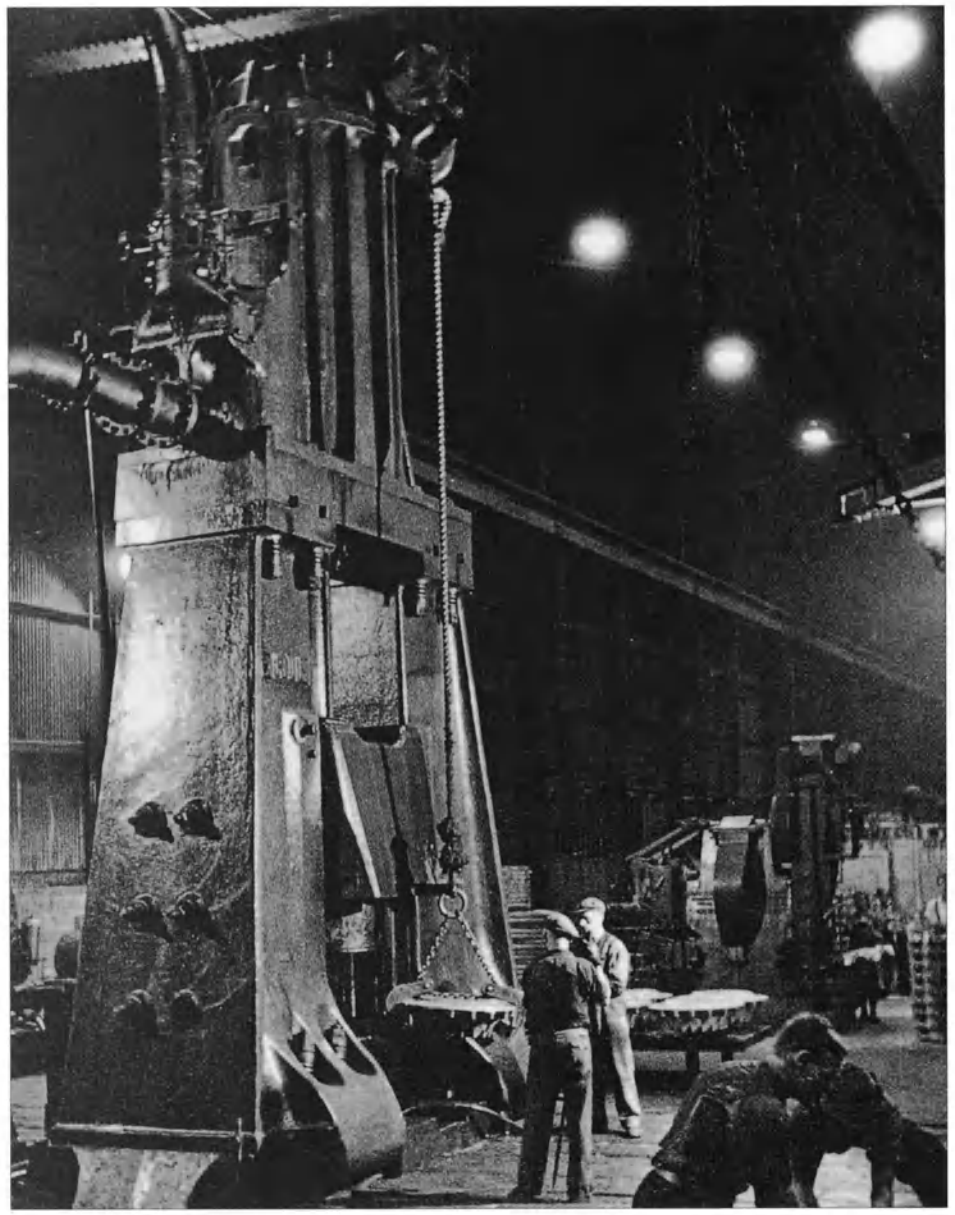
During the war the three principal companies to produce piston engines for fighters and bombers were Bristol, Napier and Rolls-Royce. Armstrong Siddeley's last big engine project was the Deerhound (abandoned in 1941) and its only major wartime contribution was the Cheetah, which was virtually confined to trainers. In 1941 Armstrong Siddeley was asked to give up development work on reciprocating engines and undertake work on jet projects. Napier's most important engine was the liquid-cooled Sabre, initially intended to give 2,000bhp (1,491kW) and primarily flown on the Hawker Typhoon and Tempest at rather higher figures, but it was to suffer many problems and setbacks before making a valuable contribution from 1944 onwards.

Bristol and Rolls-Royce were the most successful engine companies, the first specialising in air-cooled radials, the second in liquid-cooled inlines. During the 1930s Bristol developed versions of the Aquila, Mercury, Pegasus and Perseus engines before moving on to the Taurus and Hercules. The design of the 1,130bhp (843kW) Taurus was completed in the early 1930s specifically for FAA and Coastal Command purposes and it was installed in the Bristol Beaufort and Fairey Albacore; however, neither of these types was a great success and the engine saw little alternative use. In the early days of the war by far the most important of Bristol's products was the Hercules and several 'families' of this type were produced, each an improvement over the previous generation. The engine powered many RAF bombers and started life at around 1,400bhp (1,044kW) but the final versions offered as much as 1,700bhp (1,268kW). Bristol's last piston engine to reach wartime production (in 1943) was the 2,300bhp (1,715kW) Centaurus which served primarily as a fighter powerplant.

The jewel in the Rolls-Royce crown was the Merlin, a design begun in 1932 as a high-performance fighter engine. Its reputation was made by the achievements of the Spitfire and Hurricane and there were many versions with power ratings from the initial 1,000bhp (746kW) up to the 1,700bhp (1,268kW) of the 100-series used by the Hornet fighter and Short Sturgeon torpedo bomber. The Merlin also famously powered the Lancaster and Mosquito and its success overshadowed other Rolls' engines. At the start of the war these included the Kestrel (used mostly by training aircraft), the Peregrine, Exe and Vulture. Two 860bhp (641kW) Peregrines were used to power the Whirlwind but the unit was much smaller than the Merlin and thus offered less power. The 2,000bhp (1,491kW) Vulture, intended to rival the Napier Sabre, suffered severe development problems which eventually led to its abandonment and the withdrawal of the Manchester bomber that used it. The progress of the Merlin, with ever more versions, ensured that that staff and time devoted to the development and clearance of both Peregrine and Vulture was insufficient and they died a natural death. The Exe was an air-cooled inline type which reached an advanced state of development but to relieve some of the strain on the organisation Rolls asked for it to be cut out of its plans. The Air Ministry agreed on 12th December 1939 and Rolls did not renew its interest in the engine until the middle of 1943.

The next Rolls piston engine was the Griffon. This was in fact first proposed for installation in Spitfires in late 1939 but it did not, at the time, offer a sufficient advance over the latest Merlin to compensate for the extra weight. The Griffon returned to the agenda in 1941 but was dropped again for the Merlin 61 and it was not until April 1942 that the 1,720bhp (1,283kW) Griffon Mk.II entered production. Later versions reached 2,000bhp (1,491kW) but the type appeared too late to exert any strong influence in air battles against Germany. The last Rolls-Royce piston engine was to be the 3,500bhp (2,610kW) Eagle flown in a prototype Westland Wyvern naval strike fighter, but this complicated machinery was overtaken by the jet engine and eventually dropped.

The story of the jet is one of the most well known of aviation stories. All that needs to be told here is that the development of Frank Whittle's early engines, with centrifugal com-



Old and new technology seen together. A giant American-made Erie drop hammer, of 29tons (29,466kg) forging weight but really no more than an extension of the blacksmith's art, was used by High Duty Alloys to stamp some of the first aluminium impellers to be produced for jet engines. At the time the Erie was the largest of its type in the world. HDA Forgings

pressors and a large aluminium impeller, was taken under the Rolls-Royce umbrella during 1943. The first result was the 1,600lb (7.1kN) Welland which entered service in the earliest marks of Gloster Meteor fighter in 1944, and this was followed by the Derwent and then the all-new 5,000lb (22.2kN) thrust Nene. From spring 1941 de Havilland began to work on its own jet engines and ran the first 2,300lb (10.2kN) H.1 (later called Goblin) in April 1942. This went on to power the first Meteor prototype and de Havilland's own Vampire fighter and it was followed by the H.2 Ghost which reached 4,850lb (21.6kN) and was used by the Venom fighter. Mention must also be made of Metropolitan-Vickers (MetroVick) who worked on the first axial jet. This was called the F.2 and, having been initially rated at 1,800lb (8.0kN), was flown in Meteor prototype DG204; later the 4,000lb (17.8kN) F.2/4 'Beryl' went into the Saunders-Roe SR.A.1 flying boat fighter.

Just to complicate matters there was also the turboprop, which in its early days received several alternative names along the lines of 'airscrew turbine'. Here a jet was used to drive a propeller and one of the first examples of this type of engine was the Rolls-Royce RB.50 Trent. Two were fitted to Gloster Meteor Mk.1 EE227 and when flown in this form in 1945 it became the first aircraft in the world to fly with such engines. The first generation of turboprops included the Armstrong Siddeley Python and Rolls-Royce Clyde, which featured in a number of post war projects.

The first time aluminium alloys were used for fuselage and wing skins came in 1919 when the Junkers F.13 airliner employed corrugated sheet for extra strength. The first British all-metal aircraft was the Shorts Silver Streak of 1920, soon afterwards followed by the Shorts Springbok fighter, but these machines were years ahead of their time and it was the 1930s before stressed skin metal airframes were accepted in types like the Spitfire and Blenheim. Gradually the old method of metal framing with fabric covering faded away from modern high-performance aircraft but, during the war, one notable exception to metal construction was to be the all-wood Mosquito.

The improved design and construction methods that became available after the First World War promoted the development of aeroplanes in which the wing took an appreciable portion of the payload. Metal stressed skin structures contributed to the aircraft's strength and also, with a smooth exterior and thinner wings, helped to form the correct external shape. This allowed a further advance in speed and one of the first 'modern' aeroplanes to use these techniques was the American Douglas DC-3 airliner flown in 1935. Most high-performance aircraft were to have stressed skins but the trend then moved towards shell-like structures where the skin took more of the stress than any inner arrangement of spars and stiffeners, most or all of the material being concentrated in the shell. These monocoque structures were usually employed on the fuselage or engine nacelles.

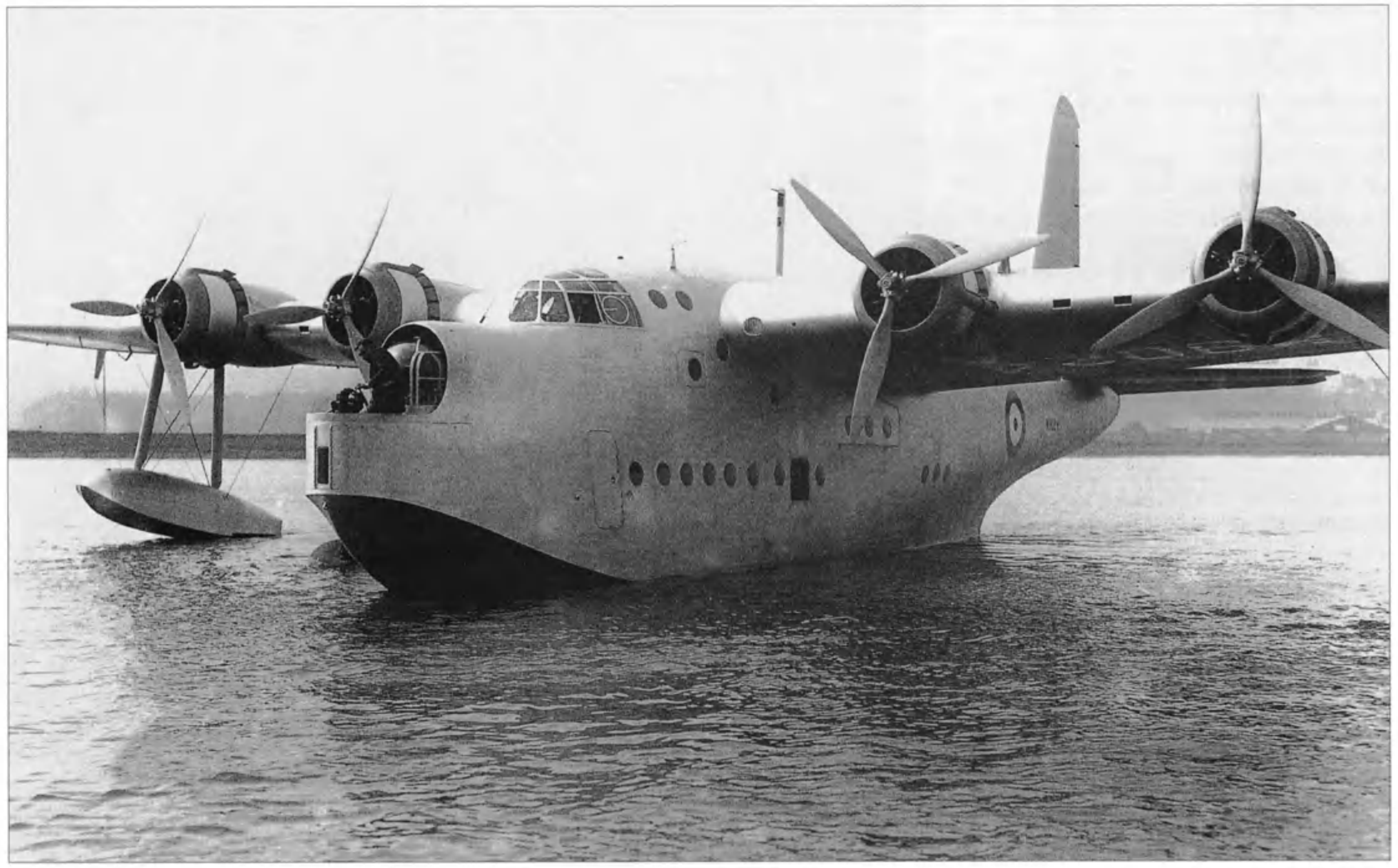
The development of selected weaponry has been touched on elsewhere, but the Second World War was the conflict where electronics first came to prominence. All sorts of 'black boxes' were produced, particularly for navigation and jamming enemy equipment, but the most well known has to be radar. This was used by large bombers for navigation but specially adapted sets were fitted to night fighters for finding enemy aircraft (Air Interception – AI) and on naval and Coastal Command bombers and patrol aircraft for seeking out enemy shipping and submarines (Anti-Surface Vessel – ASV). The Second World War was indeed a period of great technological advance.

Heavy Bombers – Estimated Data

Project	*Span ft in (m)*	*Length ft in (m)*	*Gross Wing Area ft² (m²)*	*Max Weight lb (kg)*	*Engine hp (kW)*	*Max Speed / Height mph (km/h) / ft (m)*	*Armament*
Short S.36 'Super Stirling'	135 9 (41.4)	101 0 (30.8)	2,145 (199.5)	104,000 (47,174)	2 x Centaurus CE.3.SM 2,000+ (1,491)	311 (500) at 20,000 (6,096)	23,500lb (10,660kg) bombs, 10 x 0.5in (12.7mm) plus
Vickers Bomber Designs							
Medium Bomber (22.4.42)	80 0 (24.4)	59 0 (18.0)	790 (73.5)	35,500 (16,103)	2 x Centaurus VII 2,150 (1,603)	392 (631) at 25,000 (7,620)	4,000lb (1,814kg) bombs, 4 x 0.5in (12.7mm) mgs
Medium Bomber (9.6.42)	c80 0 (24.4)	c59 0 (18.0)	c790 (73.5)	37,300 (16,919)	2 x Centaurus VII 2,150 (1,603)	353 (568) at 23,500 (7,163)	8,000lb (3,629kg) bombs, 4 x 0.5in (12.7mm) mgs
433 Warwick Mk.III	117 0 (35.7)	76 1 (23.2)	1,245 (115.8)	52,500 (23,814)	4 x Merlin LX 1,200 (895)	366 (589) at 31,000 (9,449)	8,000lb (3,629kg) bombs, 4 x 0.303in (7.7mm) mgs
447 Windsor (3rd prototype)	117 2 (35.7)	76 10 (23.4)	1,248 (116.1)	72,000 (32,659)	4 x Merlin 85 1,750 (1,305)	c360 (579) at 21,000 (6,401)	12,000lb (5,443kg) bombs (B Mk.I), 4 x 20mm cannon
601 Windsor B Mk.II	117 2 (35.7)	77 8 (23.7)	1,248 (116.1)	79,800 (36,197)	4 x Clyde RCl.1.AC 3,020 (2,252) plus 1,225lb (5.4kN)	409 (658) at 30,000 (9,144)	12,000lb (5,443kg) bombs, 4 x 20mm cannon
Long-Range High-Alt Bomber (Jan 41)	172 0 (52.4)	96 0 (29.3)	2,675 (248.8)	104,000 (47,174)	6 x Merlin RM.6.SM	352 (566) at 32,000 (9,754)	1 x 10 Ton (10,161kg) bomb, 4 x defensive guns
(Jan 42)	172 1 (52.5)	100 8 (30.7)	2,676 (248.9)	113,500 (51,484)	6 x Merlin 60	360 (579) at 40,000 (12,192)	32,000lb (14,515kg) bombs, 2 x 0.5in (12.7mm) mgs
Giant Bombers							
Avro 'Small'	182 6 (55.6)	130 0 (39.6)	3,030 (281.8)	176,000 (79,834)	8 x Unnamed 2,000 (1,491)	300 (483) max cruise at 20,000 (6,096)	19,595lb (8,888kg) bombs, defensive guns unknown
Avro 'Large'	221 0 (67.4)	152 0 (46.3)	4,880 (453.8)	220,000 (99,792)	10 x Unnamed 2,000 (1,491)	300 (483) max cruise at 20,000 (6,096)	15,000lb (6,804kg) bombs, defensive guns unknown
Bristol 'Small'	180 0 (54.9)	126 0 (38.4)	3,700 (344.1)	170,000 (77,112)	8 x Griffon 61	?	?
Bristol 'Large'	220 0 (67.1)	141 0 (43.0)	4,900 (455.7)	220,000 (99,792)	8 x Centaurus CE.12.SM	315 (507) max cruise at 25,000 (7,620)	64,000lb (29,030kg) bombs, no defensive guns (?)
Handley Page 'Conventional'	169 0 (51.5)	?	2,600 (241.8)	157,000 (71,215)	4 x Developed Sabre 3,000 (2,237)	332 (534) max cruise at 30,000 (9,144)	48,000lb (21,773kg) bombs, defensive guns unknown
Handley Page 'All-Wing' – piston	155 0 (47.2)	67 0 (20.4) fuselage	2,190 (203.7)	157,000 (71,215)	4 x Sabre 3,150 (2,349) or 3,000 (2,237)	354 (570) max cruise at 30,000 (9,144)	48,000lb (21,773kg) bombs, defensive guns unknown
Handley Page 'All-Wing' – jet	129 6 (39.5)	?	2,190 (203.7)	157,000 (71,215)	8 x F.2 2,320lb (10.3kN) thrust	500 (805) max cruise at 40,000 (12,192)	48,000lb (21,773kg) bombs, defensive guns unknown
Shorts '1'	168 0 (51.2)	157 6 (48.0)	3,340 (310.6)	170,000 (77,112)	6 x Centaurus CE.12.SM	302 (486) max cruise at 25,000 (7,620)	25,730lb (11,671kg) bombs, defensive guns unknown
Shorts '2'	168 0 (51.2)	157 6 (48.0)	3,340 (310.6)	175,000 (79,380)	6 x Sabre NS.46.SM	317 (510) max cruise at 25,000 (7,620)	25,730lb (11,671kg) bombs, defensive guns unknown
Shorts '3'	168 0 (51.2)	157 6 (48.0)	3,340 (310.6)	180,000 (81,648)	6 x Orion	329 (529) max cruise at 25,000 (7,620)	26,250lb (11,907kg) bombs, defensive guns unknown
Vickers 'A'	190 0 (57.9)	110 0 (33.5)	2,900 (269.7)	168,000 (76,205)	6 x Centaurus with turbo blowers	383 (616) at 25,000 (7,620)	56,000lb (25,402kg) bombs, 4 x 20mm + 2 x 0.5in guns
Vickers 'B'	210 0 (64.0)	112 6 (34.3)	2,900 (269.7)	168,000 (76,205)	6 x Centaurus with turbo blowers	381 (613) at 25,000 (7,620)	56,000lb (25,402kg) bombs, 4 x 20mm + 2 x 0.5in guns
Vickers 'C'	210 0 (64.0)	95 0 (29.0)	2,900 (269.7)	178,000 (80,741)	6 x Centaurus with turbo blowers	382 (615) at 25,000 (7,620)	56,000lb (25,402kg) bombs, 5 x 20mm + 2 x 0.5in guns
Vickers 'D'	210 0 (64.0)	90 0 (27.4)	2,900 (269.7)	178,000 (80,741)	6 x Centaurus with turbo blowers	386 (621) at 25,000 (7,620)	56,000lb (25,402kg) bombs, 4 x 20mm + 2 x 0.5in guns
Vickers 'E'	174 0 (53.0)	72 2 (22.0)	4,000 (372.0)	174,000 (78,926)	6 x Centaurus with turbo blowers	402 (647) at 25,000 (7,620)	56,000lb (25,402kg) bombs, 4 x 20mm + 2 x 0.5in guns
Note: Max cruise speeds for 'A' to 'E' were 318 (512), 316 (508), 317 (510), 318 (512) and 330mph (531km/h) respectively, all at 20,000ft (6,096m)							
Handley Page HP.65	113 0 (34.4)	76 0 (23.2) overall	1,162 (108.1)	70,000 (31,752)	4 x Hercules 38 with turbo blowers	350 (563) at 27,200 (8,291)	12,000lb (5,443kg) bombs, 4 x 0.5in (12.7mm) plus 1 x 0.303in (7.7mm) guns
Avro 694 Lincoln B Mk.I (flown)	120 0 (36.6)	78 3.5 (23.9)	1,421 (132.2)	82,000 (37,195)	4 x Merlin 85 1,635 (1,219)	310 (499) at 18,300 (5,578) and 69,500lb (31,525kg)	22,000lb (9,979kg) bombs, 2 x 20mm + 4 x 0.5in guns

Chapter Eight

Maritime Patrol

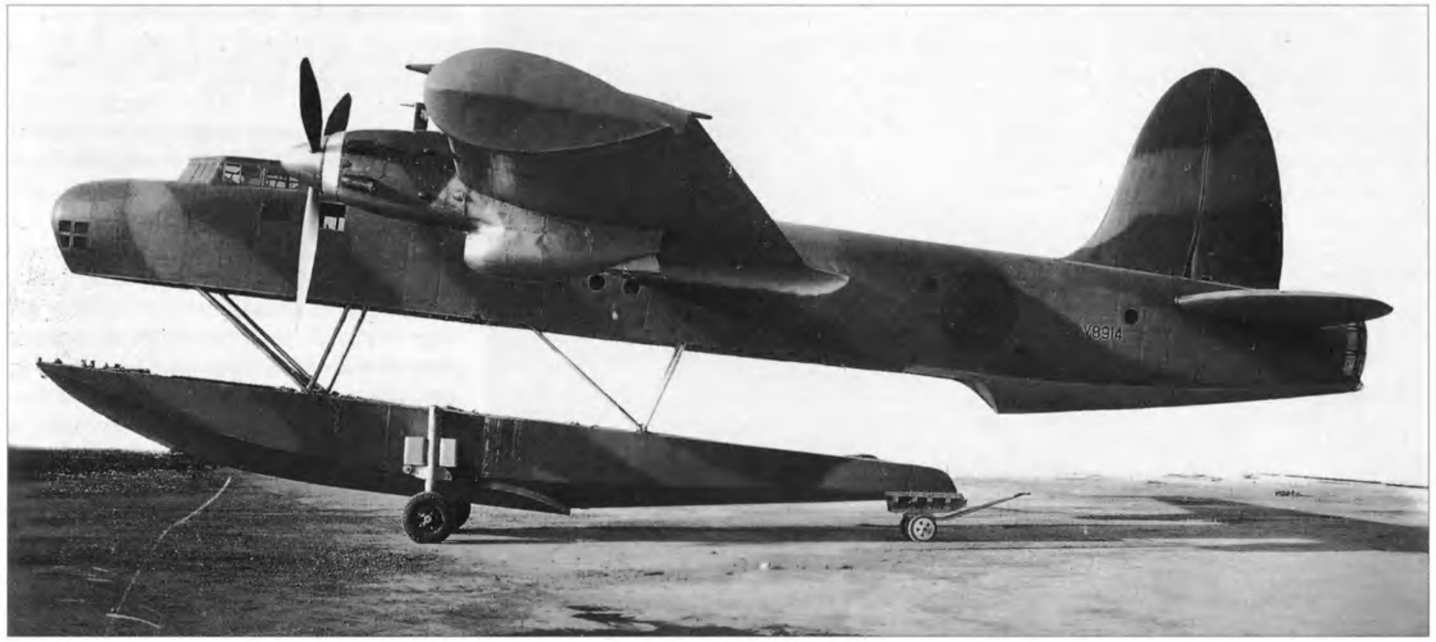


Until the 1950s the flying boat offered great benefits both to air forces and civil airlines. In particular, since it could take off with a higher all-up-weight it made possible longer range operations over the sea, although this was compromised a little by the poorer aerodynamics of the 'boat hull' which increased drag. In the short term it could also make use of any suitable landing area, thus maintaining an air presence when no land strip was available, but long-term operations would need extensive back-up facilities. The history of the RAF's wartime flying boats, used for maritime patrol and reconnaissance, is dominated by the Short Sunderland and the American Consolidated Catalina (over 650 Catalinas were bought). However, the Sunderland proved so successful that several attempts to find a replacement failed and the type stayed with the RAF until 1959.

Specification R.1/36, Blackburn B.20 and Saunders-Roe Lerwick

Prior to the outbreak of war there were plans for a smaller flying boat to undertake patrol duties. Specification R.1/36, dated 2nd March 1936, requested a maximum cruising speed of at least 230mph (370km/h) and an all-up-weight that would not exceed 25,000lb (11,340kg) and the designs tendered were the Blackburn B.20, Saro S.36, a Shorts design and the Supermarine 314. The B.20 had a horizontally-spilt body with the lower portion forming a retractable planing bottom, which was designed to cut the drag associated with deep hulls needed by monoplanes to keep their propellers above the water spray. On the water this was extended to form, in effect, a single 'float' which pushed the upper fuselage and the wings well above the water and also allowed the wing to give the precise angle of incidence required for take-off and low cruise drag; in flight the retracted float formed a smaller solid fuselage and the wingtip floats were also retractable. At the Tender Design Conference held on 22nd June the B.20 was discussed separately and one prototype, V8914, was ordered, essentially to evaluate the concept. It was powered by two Rolls-Royce Vultures and first flew in late March/early April 1940, but it crashed into the sea on 7th April 1940 because of aileron flutter.

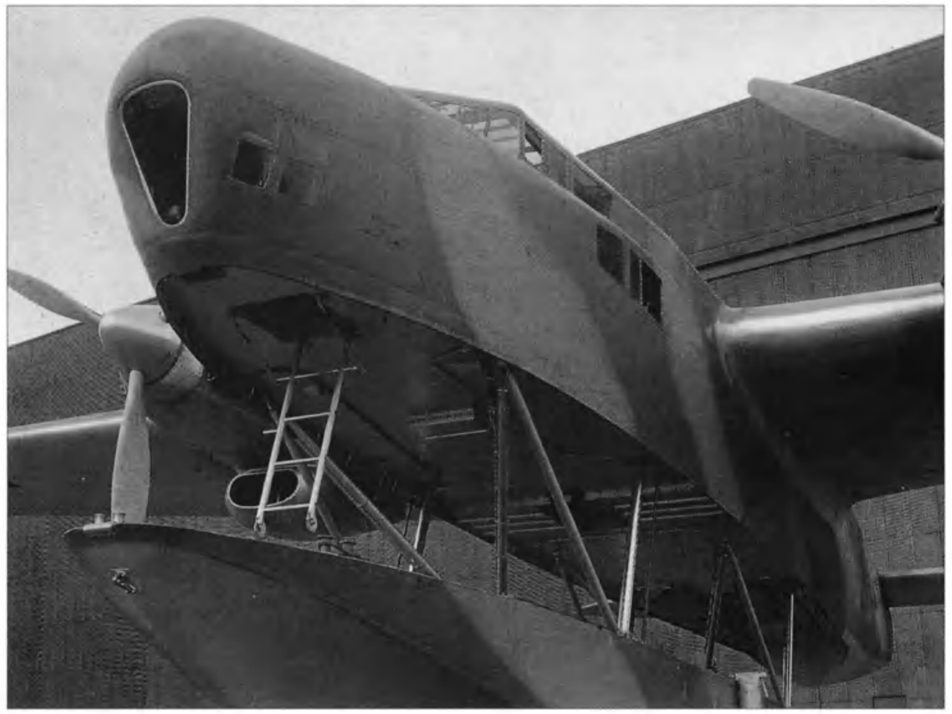
The Vulture-powered Supermarine 314 was considered to be the favourite, with Saro and Shorts equal second, and in due course it was ordered 'off the drawing board'. However, Supermarine's work on the Spitfire held up proceedings and the company estimated that work could not start within two years. In the meantime Saro redesigned its S.36 and replaced the original shallow hull and gull wing with a deeper body and high-mounted cantilever wing; as a result the R.1/36 contract was transferred to Saro with a replacement 'off the board' order. Having won by default the first S.36 was flown in early November 1938 and the type was named Lerwick but only 21 were ever built. There were misgivings about the design itself and orders were cancelled and reinstated, and then the aircraft was found to have a disappointing performance with a top speed short of that specified. Its flight characteristics and water performance were also poor but the type did fulfil a limited service career before finally being withdrawn in 1942.



Opposite page: **Close up of Sunderland Mk.I N9024.** Short Bros

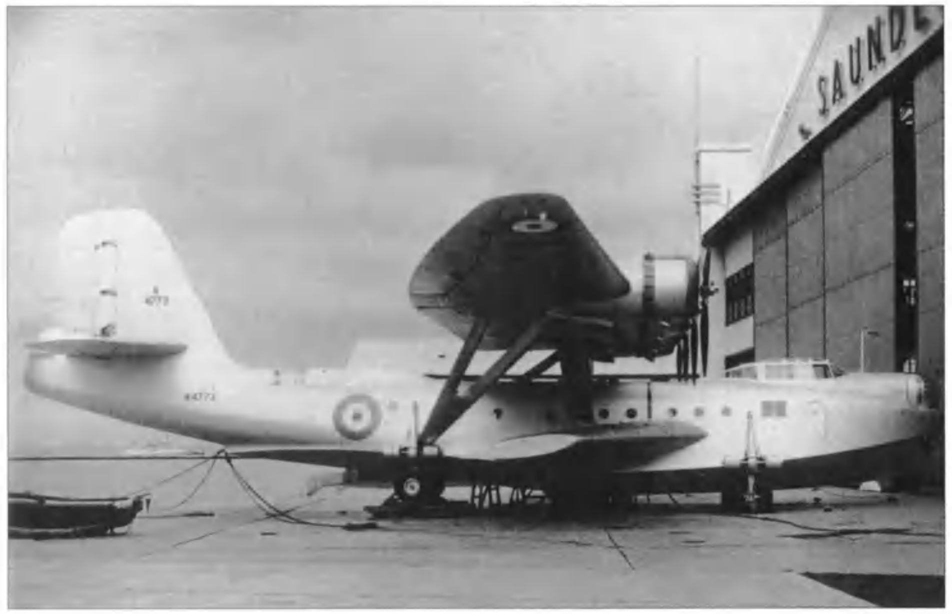
Above and right: **Two views of Blackburn B.20 V8914, the second showing detail of the retractable planing bottom.** Ray Sturtivant

Below: **L7265 was one of a very small number of Saro A.36 Lerwicks to be built (18 aircraft plus three prototypes).**

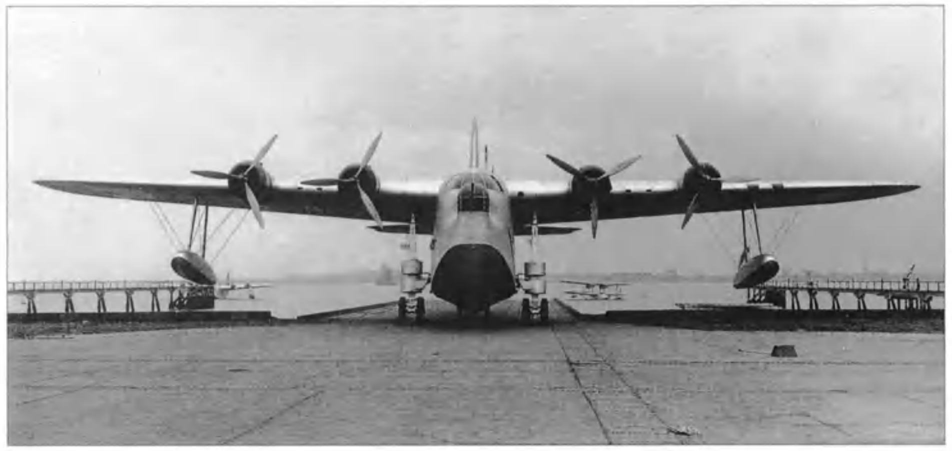


Specification R.2/33, Saro A.33 and Short Sunderland

Specification R.2/33 of 23rd November 1933 requested a four-engined general purpose boat seaplane to replace the Short Singapore III. The projects selected for flight test were the Saunders-Roe A.33 and Short S.25 and in 1934 a single prototype of each was ordered,



Saunders-Roe A.33 K4773. Eric Morgan



Short Sunderland prototype K4774 photographed at Felixstowe in August 1938.

The sixth production Sunderland Mk.I was L2163, seen here as DA:G of 210 Squadron in 1939-40.

with serials K4773 and K4774 respectively. Saro's A.33 had a fabric-covered parasol wing-mounted on struts well clear of the fuselage, the high position providing sufficient water clearance for the engines while also permitting the use of a relatively small low-drag hull. It had four Bristol Perseus XII engines, a streamlined all-metal hull and, instead of wing floats, huge hull-mounted aerofoil section sponsons to provide stability, an unusual feature in British design.

K4773 first flew on 14th October 1938, a full year after the S.25, but its water performance was poor. Porpoising (nose pitching both up and down) was experienced together with excessive wave pressure build up on the sponsons. On 25th October, during a take-off run, it hit the wake of a passing ferry which made it bounce and stall and resulted in a wing failure inboard of the starboard engines; one of the propellers also pierced the hull and it was clear that repairs were not worthwhile. The A.33's all-up-weight was 41,500lb (18,825kg), although all flight testing was performed at a take-off weight of 31,500lb (14,288kg), and it had a maximum speed of 200mph (322km/h). Initial production contracts for the A.33 and S.25 were placed in March 1936 before their prototypes were completed, but the order for eleven A.33s was now cancelled along with all further development.

Eleven Short S.25s were ordered and the type was named Sunderland. The Air Ministry and RAF voiced a few criticisms and one brought a change to the defensive armament (a large 37mm Vickers nose gun was replaced by a single machine gun while the rear turret was equipped with four Browning machine guns). This had an appreciable effect on the boat's layout in that just over 4° of sweep had to be introduced to the main wing spar. Originally the leading edge had been straight but sweepback was now required to compensate for the change in CofG caused by the heavy tail turret pushing back the centre of pressure. In turn this forced a redesign of the lower hull to accommodate a change in the hydrodynamics.

These alterations, however, evolved after the construction of K4774 had begun and it was decided to proceed with the straight wing on that aircraft. K4774 was launched into the River Medway on 14th October 1937 and its maiden flight followed two days later. Three more flights were completed before K4774 was returned to the factory to receive its swept wing, a repositioned main step on the planing bottom and the correct engines – Pegasus XXIIs (Pegasus Xs had been fitted as a temporary measure). The planing bottom, that part of the underside of a hull or float which is designed to develop hydrodynamic lift, was tapered at its rear end to a vertical knife edge. In timing the Sunderland came behind Short's pre-war 'C' Class civil flying boats which allowed the military type to benefit from the former's development programme and a particular example was this improved knife-edge arrangement that replaced the transverse step of the civilian machine. The Sunderland prototype only was to receive a main step equipped with a retractable fairing, operated by a member of the crew inside the bomb loading compartment.

Sunderland hull shapes were tested on a Short S.22 Scion Senior seaplane, a four engine twin float machine about half of the size of a Sunderland. Since it appeared to make an ideal test model an example was bought by the Air Ministry in 1939 for hull experiments. The twin floats were removed and a central float fitted under the fuselage to act as a half-scale model of its big brother's planing bottom. Wingtip floats on long struts were added and the Scion Senior 'flying-boat', now serialed L9786, made a first flight in this form on 18th October 1939. It was sent to MAEE at Helensburgh to measure hull resistance during high-speed taxying (MAEE was based at Felixstowe before the outbreak of war) and the data collected helped in the design of a faired main step introduced on the Sunderland Mk.III. The Scion Senior was used until 1944 and its correlation with the behaviour of the full-size Sunderland proved far more accurate than small water tank models. By comparison Saunders-Roe's tank testing failed to indicate that its A.33 and Lerwick boats would both perform badly on the water.

The first Sunderland Mk.Is entered service in June 1938 and further updated versions followed with improved armament and engines. The final Mk.V was powered by the 1,200bhp (895kW) Pratt & Whitney R1830 Twin Wasp and a total of 749 aircraft was built. Sunderland production began before the war started and closed after the end of hostilities.

Short Seaford MZ269 taking-off. Paul McMaster, Ulster Aviation Society

Short S.45 Seaford

A more powerful Bristol engine was the Hercules which Shorts used on its Stirling bomber (Chapter 6) and it was realised that this unit could improve the Sunderland's speed. Work began in late 1941 and the result was the Mk.IV, covered by Specification R.8/42 of November 1942, which had 1,700hp (1,268kW) Hercules XIXs. Orders followed for two prototypes, MZ269 and MZ271, and forty production aircraft. The changes to the airframe were minimal but they included 3ft 3in (99cm) of additional hull length, 1ft (30.5cm) more maximum beam, a carefully redesigned planing bottom with a 3in (7.6cm) deeper main step and almost 5° of dihedral on the tailplane to keep it clear of spray. The wing was unaltered but a powerful defensive armament was fitted.

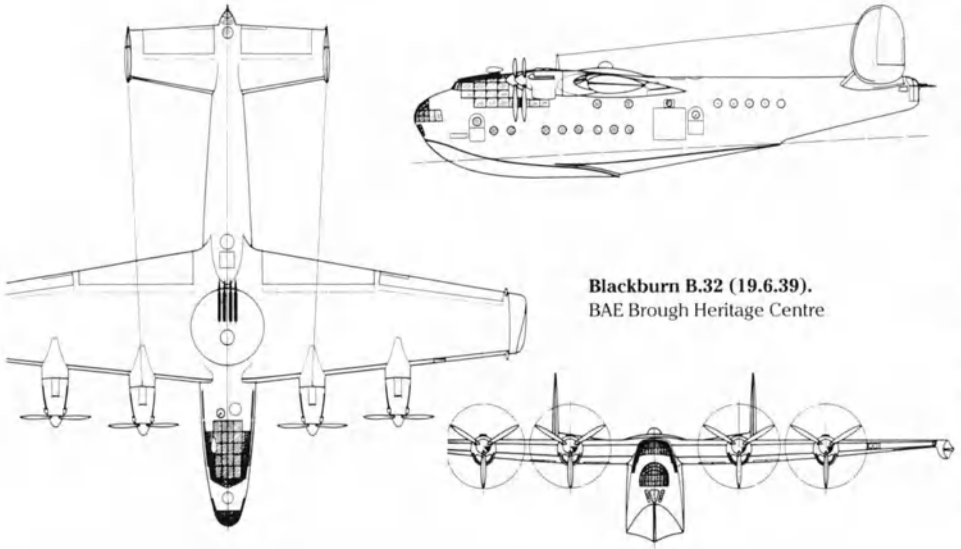
The Mk.IV was intended to serve against Japan and MZ269 first flew on 30th August 1944. It had been discovered that the normal Sunderland vertical tail had insufficient fin and rudder area for yaw control with both engines out on one side, so a bigger fin (2ft 9in [84cm] taller) plus a 20% larger tail were fitted which worked well but needed an additional dorsal fin fairing to eliminate a new problem of rudder-locking. This upgrade was renamed the S.45 Seaford GR Mk.1 but the increase in maximum weight to 75,000lb (34,020kg) restricted the expected improvements in performance and, once the Pacific war was over, there was little point in putting it into service; the gain in speed over the Mk.III Sunderland was only about 32mph (51km/h). On 24th August 1946 Shorts was told that there would be no more orders for the Seaford, or any additional Sunderland Vs, after the eight Seafords then on order. These were completed but most were then converted for civilian use; the other production airframes were finished as Solent airliners or cancelled while the two Seaford prototypes were scrapped in 1947.

Specification R.5/39

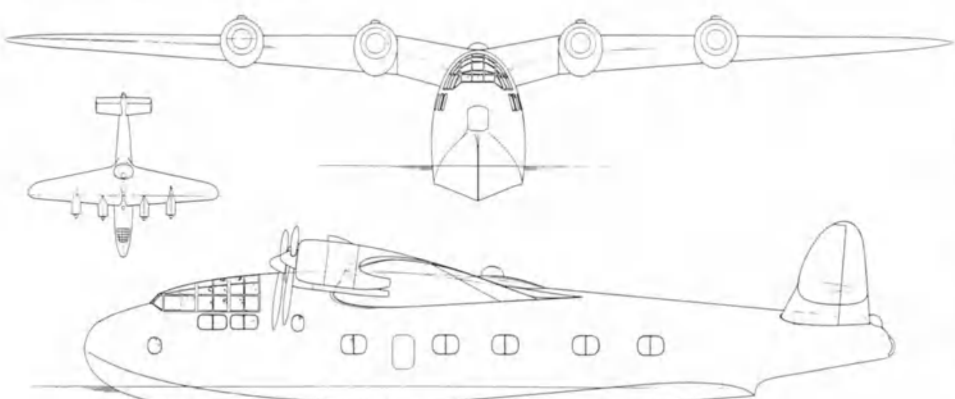
In July 1938 draft proposals were prepared for Specification R.3/38 which was intended to produce a flying boat that was faster, and preferably smaller, than the Sunderland. The service load, 5,000lb (2,268kg), was broadly the same as Shorts' boat and investigations by RDT showed that there were good prospects of meeting the Air Staff's main requirement – speed – with four 1,000bhp (746kW) engines, either the Exe or the Taurus. Normal gross weight was estimated to be 45,000lb (20,412kg). While the details of R.3/38 were being discussed the Air Staff's policy on defensive armament was altered and a revised specification, issued as R.5/39 in April 1939, appeared with a four-cannon turret. A normal range of 1,500 miles (2,414km) was required with minimum cruise 235mph (378km/h). Four companies tendered designs, each using light alloy construction with fabric-covered control surfaces.

Blackburn B.32

The brochure stated that this design met all of the military, operational and navigational requirements without any sacrifice in water or aerodynamic performance. The tailplane had pronounced dihedral which increased the clearance between the outer surface of the tailplane and the wave formation trailing from the main step, so the hull depth was kept to a minimum. Tip floats, retractable or fixed, were used which, when retracted, formed the wingtips and Handley Page type slotted flaps were fitted. The chosen engine was the Hercules, with the Griffon as an alternative (each tender used these), and the units were fitted well forward of the leading edge so that the full slipstream effect on lift was available for take-off. There were three bomb cells in each centre plane and two more bombs could be carried on swinging carriers at each side of the hull.



Blackburn B.32 (19.6.39). BAE Brough Heritage Centre



Supermarine 328 (6.39). Eric Morgan

A four cannon turret was mounted between the two main wing spars close to the CofG and a large 12ft (3.66m) diameter cupola, shaped to form part of a sphere, rotated with the turret. The wing sections and thicknesses were adjusted so that the cupola was faired into the wing top surface. A single pillar-mounted cannon was placed in the tail turret with a two-piece transparent fairing which slid backwards on circular tracks to provide an opening for the gun to fire. The overload internal fuel totalled 3,190gal (14,505lit) and the normal load around 1,600gal (7,275lit). Top rate of climb for the Hercules was 1,830ft/min (558m/min) at 2,000ft (610m), time to 5,000ft (1,524m) 3 minutes, cruise speed 262mph (422km/h) at 2,000ft (610m), maximum range 4,080 miles (6,565km) and service ceiling 30,700ft (9,357m), for the Griffon these were 1,980ft/min (604m/min) at 6,800ft (2,073m), 2.6 minutes, 275mph (442km/h) at 6,400ft (1,951m), 4,000 miles (6,436km) and 28,500ft (8,689m). The first prototype would take 24 months to produce.

Saunders-Roe S.38

This was a development of some early work done to R.3/38, which had begun with an aircraft powered by four Taurus engines. This new project's total fuel was 3,830gal (17,415lit) with the normal load 2,030gal (9,230lit). The aircraft had a high wing with a single spar, inward retracting floats, four bomb cells in each wing, twin rudders, a four-gun amidships turret and a single gun tail turret. The Hercules gave a time to 5,000ft (1,524m) of 3.2 minutes and a maximum range of 4,130 miles (6,645km) while the cruise speed was 258mph (415km/h) (Griffon 265mph [426km/h]) at 15,000ft [4,572m]). The quote for the first prototype was also 24 months. To support its R.5/39 studies and assess the aerodynamic and water properties, Saro built a flying scale model of this design called the S.37 Shrimp. Despite R.5/39 being abandoned in October 1939, Saro continued these studies as a private venture and the Shrimp was flown for the first time in early October.

Short Brothers R.5/39

This project used a two-spar wing system similar to the Stirling bomber and had fixed wing floats, a high wing and a single fin and rudder, eight bomb cells in each outer wing and the four cannon turret placed between the spar frames. Total fuel capacity was 3,360gal (15,278lit), cruise speed (Hercules) 236mph (380km/h) and (Griffon) 219mph (352km/h) at 5,000ft (1,524m), sea level rate of climb (Hercules) 1,470ft/min (448m/min) and range (Griffon) 3,645 miles (5,865km). Shorts expected to produce a prototype in 21 months.

Supermarine 328

Supermarine declared that this design offered exceptional performance, a high degree of seaworthiness and an efficient bomb installation and the result was 'a very long range flying boat capable of operating away from its base for extended periods .... and a very serviceable bomber with a performance that contemporary bombers will be unlikely to equal'. Its wing construction and bomb layout closely followed those adopted on Supermarine's B.12/36 (Chapter 6) which was now under construction. The wing size and overall dimensions had been kept to a minimum and the single-spar construction allowed the interior of the wing to be put to the fullest use. Thus, with the torsion nose containing fuel ahead of the spar and all of the bombs and the retracting float placed aft of the spar, the wing was almost completely filled and could not be made any smaller; slotted flaps were employed.

It had also been found possible to design a hull of 'excellent form' without sacrificing water performance. A simple scheme had been worked out for the retraction of the main step in flight and a hydrofoil type of float had been developed that was housed completely within the wing, features which saved a large amount of fuel weight. The float retracted into the wing using a method which was similar in principle to the Spitfire's undercarriage. Each wing had eight bomb cells, level with and between the two engine nacelles, and could take 250lb (113kg) bombs; the four inner cells were also large enough to take 500lb (227kg) bombs and the four cannon turret was housed in the rear centre section with a single cannon at the rear. Respective cruise speeds for Hercules or Griffon were 268mph and 250mph (431km/h and 402km/h) at 5,000ft (1,524m), time to 5,000ft 3.6 and 3.0 minutes and service ceilings 22,000ft (6,706m) and 25,500ft (7,772m). The normal fuel load was 1,830gal (8,321lit) and overload 3,810gal (17,324lit), maximum range 5,000 miles (8,045km) and 24 months was the time quoted to produce the first machine.

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On 18th July 1939 RAE Farnborough reported on these designs and noted that Shorts' single rudder restricted the rear field of fire while Blackburn had poor bomb stowage. It placed Supermarine as the best general layout and Saro second; Short and Blackburn were 'inferior'. The Tender Design Conference, held on 28th July, generally agreed. Saro's retractable float was described as 'an excellent feature' but Short's experience in constructing large flying boats gave extra confidence because, while that company's design had very conservative general features, if the R.5/39 type was required at an early date it was the only one that could be ordered with a guarantee of delivery; this design would also have to have twin rudders.

The Conference considered that the Supermarine 328 was the best compromise but, if it was adopted, it was recommended that the design's wing area should be slightly increased and Saro's retractable wingtip float should be included together with larger airscrews; the latter would be made possible by moving the inboard engines some 10in (25.4cm) further outwards. The question of Supermarine agreeing to provide a half-scale model would also need investigation. The second string was carefully discussed and Saro's project was felt to be 'very enterprising', while the company was also developing a half-scale model. The spars and integral tanks would need some redesign but it was agreed that, with these changes, the design should be recommended. Blackburn's B.32 was placed last on all counts and contained so many disadvantages that it was not worth pursuing.

However, at a meeting held on 4th October 1939 to discuss the future experimental aircraft programme, it was stated that the Air Staff would not call for a replacement for the Sunderland for some time and so R.5/39 as a requirement could be abandoned. By 4th December the Air Staff had proposed some modifications to produce a Mk.II Sunderland with an extra 500gal (2,273lit) of internal fuel, changes to the hull forebody, redesigned bomb gear, folding wingtip floats (which increased cruise speed by 4mph [6.4km/h] and added a little range) and twin fins in place of the existing single fin (to reduce a slight tendency to swing on take-off). However, some strong voices complained that a replacement aircraft should have been put in hand over twenty months ago and that the R.5/39 prototype should by now have been well on the way to completion. R.5/39 had suffered delays but its requirements came very close to the American Consolidated Coronado boat now in production. In contrast, others felt that R.5/39 had grown from 'a smaller and faster Sunderland' to almost a 'boat version of the B.1/39' (Chapter 6).

On 13th January 1940 CinC Coastal Command, in a letter to the Air Staff, expressed his concern regarding the decision to abandon R.5/39 and he urged the continuance of flying boat development in general, perhaps at an all-up-weight of 84,000lb (38,102kg). R5/39's requirements were now reconsidered in relation to the newly proposed 'smaller flying boat' (later called R.13/40 and described below) and to the improved Sunderland (the latter was continued and a great deal of work completed, which made it possible for the type to take-off at 56,000lb [25,402kg] weight). A meeting convened on 24th April recommended that an order should be placed with Shorts and Saro for a flying boat to R.5/.39, but with Centaurus or Sabre engines instead of the original Hercules which would increase the all-up-weight from 65,000lb (29,484kg) to roughly 100,000lb (45,360kg).

Saunders-Roe S.38A & S.39

In the meantime Saro's private venture work had continued and the S.38A was drawn in April 1940 with Centaurus engines, the same guns as the S.38, all-up-weight 62,000lb (28,123kg), 4,000lb (1,814kg) bombs and maximum speed 285mph (459km/h) at 15,000ft (4,572m). Saro also produced the alternative S.39 design which offered a range of 5,000 miles (8,045km) and had four turrets with machine guns. It was powered by four Centaurus but the Napier Sabre was an alternative. (Blackburn had also replaced its B.32 project with the twin Centaurus B.39, again prepared to R.5/39).

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The momentum for a new flying boat grew and on 25th May 1940 instructions were given for development orders to be placed with Shorts and Saunders-Roe. In July a new specification, R.14/40, replaced R.5/39 which detailed a maximum load approaching 100,000lb (45,360kg) and 20,000lb (9,072kg) of bombs.

Saunders-Roe S.41

Saro revised its S.39 project to R.14/40 with a span of 137ft 6in (41.9m), length 101ft 6in (30.9m) and the same wing area, and in addition returned to the four-cannon turret. There was also the S.39A with four Hercules, a four cannon turret and a retractable planing bottom along the lines of Blackburn's B.20 (this project was not tendered). In January 1941 the company began the S.41 with a powerful defensive armament of four cannon in a rear turret and 12 machine guns, four in each of two dorsal turrets and in a nose turret. It had four Centaurus, an all-up-weight of 110,000lb (49,896kg) and a range of 3,800 miles (6,114km), and was also offered to R.14/40. (Drawings of the Saro S.38, S.39 and S.41, and the P.104 and P.162 below, can be found in the books *From Sea to Air* and *Saunders and Saro Aircraft since 1917*).

Short Brothers S.35 Shetland

Shorts too had continued its work although details of the company's efforts to R.14/40 have not been found. In the event the two rivals were asked to submit a combined project, otherwise no order would be forthcoming, which resulted in the Shetland. This was primarily a Short design but Saro and Shorts agreed to co-operate on the aircraft's manufacture, the former having the responsibility for the 150ft (45.7m) wing and, thanks to the work achieved with the Shrimp, some of the hull's hydrodynamic design while Shorts did the hull and tail unit and undertook final assembly. The first prototype, DX166, made its maiden flight on 14th December 1944 and performed well both in the air and in the water, but the end of the war meant that its time had passed. This aircraft was accidentally burnt at its moorings on 28th January 1946. As early as mid-1943 the RAF was looking at converting the Shetland for transport duties and an order for six such aeroplanes was seriously considered in mid-1945. The second prototype, DX171, was converted for civil use but this took some time to complete and it did not fly until 17th September 1947; it was too late and the aircraft was scrapped in 1951.

Blackburn B.40

This was a proposed improvement of Blackburn's B.20. The meeting held on 24th April 1940 (above) also recommended development of the B.40 to meet a requirement for a small flying boat of high performance and long range. It was thought that, with two Sabres or Centaurus and based on the Ler-

Short Shetland prototype DX166 in 1944. When launched this was the biggest British aircraft built to date.

wick specification, an aircraft of about 38,000lb to 40,000lb (17,237kg to 18,144kg) would meet the speed requirements but might be too small to reach some of the range limits. The B.40 was initiated as a DTD experiment to acquire information on the retracting hull method of improving the performance of small flying boats and Specification R.13/40 was subsequently allotted to the design.

By January 1941 the B.40 had become a 'replacement' for the Sunderland 'to do better and more economically what the Sunderland already does well', but not for duties beyond the Sunderland's powers (which were some of the objectives of R.14/40). On 28th January W S Farren reviewed the B.40 which, in comparison with the Sunderland, had a better top speed (by 35mph [56km/h] to 40mph [64km/h]), a better cruise speed (25mph [40km/h] to 30mph [48km/h]), at least equal range and a heavier armament. Farren described the B.40 as a single central float plane in which the 'float' or 'pontoon' could be drawn up to the fuselage and faired with it; the wingtip floats were also retractable. Due to the need to keep the airscrews and tail clear of the sea, the hull depth for a boat the size of the Sunderland was several feet more than was needed to accommodate the crew and equipment, consequently the hull's air drag was high. With a retractable single pontoon both fuselage and pontoon could be made the correct size and their combined air drag was about 75% of that from the corresponding boat hull. All of the fuel would go in the pontoon.

Farren added that the case for development depended on whether there was a continuing need for a seaplane of this general size, whether the Sunderland was good enough, or could be developed to be good enough, and whether the technical promise of the R.13/40 was backed by sound evidence. He felt that the loss of the smaller B.20 experimental prototype was irrelevant – the cause was known (aileron flutter and nothing to do with the retracting pontoon) and the retracting gear was simple and had given no trouble. The Sunderland could 'scarcely be taken much further' and it could not carry engines that would give it the speed of the R.13/40; this older type was being developed as far as possible but it remained a Sunderland – well tried, reliable, slow and overroomy. The B.40 had two Centaurus which, at their present power, was equivalent to the Sunderland's four Pegasus and there was good reason to believe that the newer engine would eventually give 20% more power.

The B.40 would cruise at 165mph (265km/h) and potentially offered a range of 2,300 miles (3,701km), dependent on the engine manufacturer's figures for fuel consumption. Its defensive armament was one 20mm cannon in a power mounting, two turrets each with two 0.5in (12.7mm) machine guns and four hand-held 0.303in (7.7mm) machine guns. Farren concluded that, providing the appropriate duties for a Sunderland size of seaplane remain to be carried out, duties for which an R.14/40 was extravagant and for which a landplane was unsuited, the technical case for building the B.40 was good. It offered advances in air and water performance and a number of operational advantages.

However, on 3rd March 1941 DD/RDT stated that the required range, now 3,500 miles (5,632km), could not be met by the B.40 and ACAS(T) observed that the aircraft therefore ceased to be of operational interest. Nevertheless the work continued and on 19th September two prototypes, ES966 and ES979, were ordered. On 20th December N E Rowe, DTD, declared that the 'range now available, viz. 3,050 miles (4,907km) without a bomb, is not acceptable to the Air Staff. Moreover the single-engined performance of the aeroplane is quite unacceptable'. The single-engine case had grown steadily worse since the design had been first put forward, when the emphasis was on high performance rather than very long range and a weight of around 52,000lb (23,587kg) was in mind.

The Air Staff saw no requirement for a small high-performance boat of the R.13/40 class and pointed out that, compared to the Sunderland Mk.III, it showed very little advance in range – which was now the major requirement. In addition it had been found that landplanes were acceptable for ranges of 2,500 miles to 3,000 miles (4,023km to 4,827km) and were now being used. Rowe added that at the present weight and size, made necessary to approach Air Staff requirements, the retracting hull showed practically no advantage and so the value of the experiment would be lost. Since the Air Staff had no operational use for the boat it was now necessary to cancel it, and this had been agreed.

Specification R.2/48

This 1948 requirement almost falls outside the period covered by this book but it belongs here because it represents, for the RAF at least, pretty well the last throw of the dice for the military flying boat. R.2/48, dated 12th November 1948, was the last British specification to be issued for a maritime reconnaissance and anti-submarine flying boat and asked for a 4,000lb (1,814kg) bomb load (or 8,000lb [3,629kg] with reduced fuel), a maximum speed of 350 knots (403mph/648km/h) and a design that was suitable for the economic production of eighty aeroplanes. Published sources state that the Blackburn B.78 was designed to R.2/48 but official documents make no reference to it.

Saunders-Roe P.104

During the period 1948 to 1953 14 schemes of flying boat were prepared by Saro to the requirements. They all had four engines (Centaurus, Griffon or Nomad), used either single or twin fins and rudders or a V-tail, a retractable ASV radar scanner mounted in the underside either in the nose or behind the wing and spans varying between 134ft (40.8km) and 168ft (51.2km). The layout proposed to R.2/48 in early 1949 had twin fins, four compounded Griffons with contra-rotating propellers, two 20mm cannon in a dorsal turret, a ceiling of 21,000ft (6,401m) and a 12 hour endurance. A first flight would be made 152 weeks from ITP.

Short Brothers and Harland P.D.2

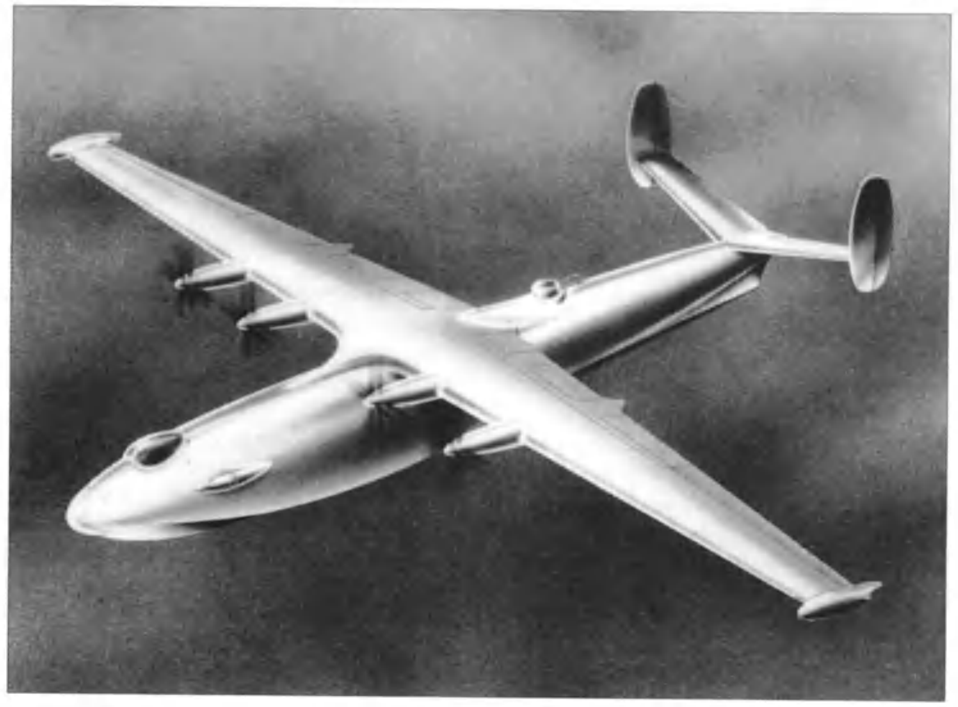
Two projects were offered, one a new design and the other a development of the R.14/40 Shetland set at 128,500lb (58,288kg) all-up-weight and giving a maximum speed of 281mph (452km/h) at 10,000ft (3,048m). The modified Shetland had a ceiling of 24,500ft (7,468m) and an endurance of 15.7 hours, the Nomad-powered P.D.2 32,000ft (9,754m) and 14.6 hours and the Centaurus P.D.2 27,600ft (8,412m) and 13.7 hours; each project had a twin 20mm dorsal turret. For its maiden flight the Shetland variant would only need twelve months from ITP but the P.D.2 would need 35 months.

Supermarine 524

Investigations had shown that it was quite feasible to design a flying boat to take any of three alternative engines and still meet the requirements. The Napier Nomad compound engine resulted in the lightest boat, with a fuel requirement of 2,620gal (11,913lit), but this engine was untried and Supermarine felt it was unwise to rely on it at the exclusion of other types. The Centaurus piston needed 3,700gal (16,824lit) of fuel but by the time the boat was in production this engine could be obsolescent. However, there appeared to be no conventional British alternative and for this reason the Centaurus could remain in service for many years. The Bristol Proteus turboprop called for a slightly larger boat and the fuel requirement was 5,000gal (22,735lit); in each case all of the fuel was housed in the wings. The maximum continuous cruising speeds were Centaurus 326mph (525km/h), Proteus 389mph (626km/h) and Nomad 381mph (613km/h), sea level rates of climb 1,410ft/min (430m/min), 2,060ft/min (628m/min) and 1,420ft/min (433m/min) and service ceilings 32,000ft (9,754m), 35,200ft (10,729m) and 34,600ft (10,546m); each offered a twelve hour endurance.

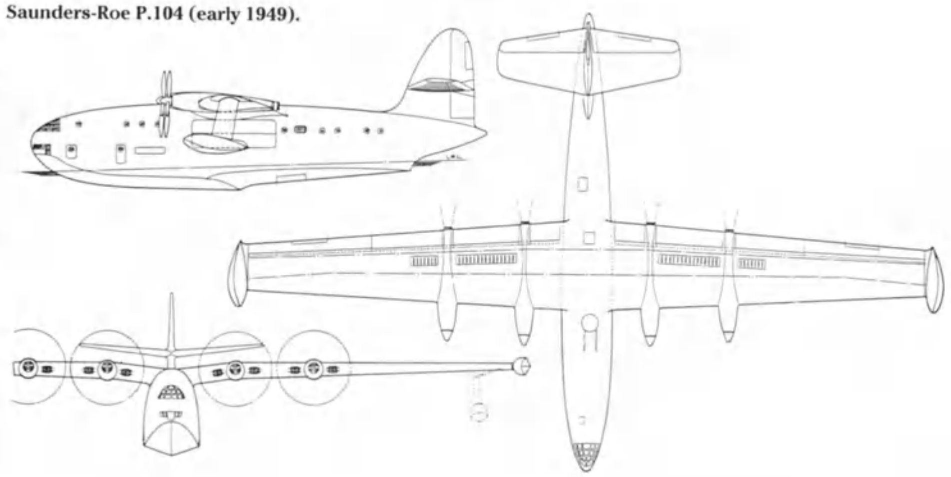
Apart from what Supermarine called 'the powerplant adaptability', its proposals were conventional. A single-spar light alloy wing was used and a retractable twin 20mm turret was fitted in the hull roof just forward of the wing. The ASV scanner was mounted in the bottom of the hull in a retractable drum set level with the wing trailing edge. During operations this projected beneath the hull so that the field of search embraced the whole lower hemisphere and then for landing it retracted into a watertight compartment, the aperture in the hull bottom being closed by electrically-operated doors. The bombs and Pentanes (anti-submarine missiles) were carried in compartments let into the sides of the hull beneath the wings, which for release were run out on carriers along the inner wing. Aft of the entrance door a compartment was provided on each side to take four rockets with 25lb (11.3kg) or 60lb (27.2kg) heads and these were carried on frames and rollers so that they could be run out for firing. The first flight would take 160 weeks from ITP.

An RAE assessment dated 17th June 1949 noted that the Shetland variant (essentially an attempt to resuscitate an old design) did not adequately meet the requirement while Shorts' new design had a very poor flight deck layout. The latter was in fact a disappointment and gave the impression that Shorts'



Supermarine 524 with Proteus engines (early 1949). Eric Morgan

Saunders-Roe P.104 (early 1949).



An Avro Shackleton Mk.1 on display at Farnborough, 4th September 1950.

project office had concentrated on performance to the exclusion of all other features; for example the brochure barely mentioned strength and stiffness. In addition the hull design was quite old and, in general, the tender showed 'little imagination'. Saro's design (the most comprehensive submitted) was 'a very good attempt' but the hull form left little room for future needs; it did, however, employ the latest ideas on hulls to improve the rough water characteristics. Supermarine's 524 was very attractive and looked good for long-term development but its hull form and method of bomb carriage were inferior to Saro. Supermarine's design was placed second to Saro's.

At the Tender Design Conference held on 25th July Short's modified Shetland was ruled out because of its high weight, but there was general agreement that Saro's P.104 was technically superior to the others. However, it would have to be re-engined with the Centaurus while the question of a further change to the Nomad would need to be considered later. Despite these opinions, in due course a decision was made to place a development contract with Shorts for an R.2/48 aircraft powered by four compound Nomad or Centaurus and the company was told in early 1950 that this project was likely to come to them. Consequently Shorts began reserving capacity but the programme was then put in suspension pending a decision as to whether a future flying boat was needed.

In July 1951 the whole future of the military flying boat was in question. The venerable Sunderland was still in service but needed replacing and a decision was required as to what aircraft should fill its role. VCAS produced a long report examining the full subject of maritime reconnaissance worldwide and gave support to the R.2/48. The Ministry of Supply (which had replaced MAP) felt strongly that the contract should be placed with Shorts but the Air Staff felt that Saro's design was still the best. VCAS declared that he considered the R.2/48 should be developed and that the work should go to Saunders-Roe, and he invited the Air Council to agree that they should proceed and the Ministry of Supply to place the work with Saro.

Saunders-Roe P.162

In 1952 Saro refined its R.2/48 project into the P.162 long-range reconnaissance and anti-submarine flying boat. The compounded Griffons gave way to four Centaurus, then four Nomads or a mixture of four Centaurus with two more Avon jet engines. The highest weight of the various studies was 155,000lb (70,308kg), the maximum span 157ft (47.9m) and length 126ft 6in (38.6m). The ultimate P.162 had four Rolls-Royce RB.109 turboprops with bomb bays in the lower inboard nacelles, a span of 136ft (41.5m), length 114ft 7in (34.9m) and all-up-weight 148,000lb (67,133kg).

In the early 1950s R.2/48 was renumbered and updated to R.112D but, despite VCAS's thoughts, the flying boat era was all but over. By 1952 it was clear that a flying boat was not required for Atlantic operations because these were now well covered by land-based types like the Avro Shackleton. By the mid-1950s British interest in the military flying boat had ceased.

Avro Shackleton

The need to deal with German U-boats in the Battle of the Atlantic was a key driving force behind the introduction of wartime land-based patrol aircraft. Very long range was essential to try and close, as much as possible, the gap in the centre of the ocean which lacked maritime air cover to assist naval surface ships in defending their merchant convoys. Versions of several bomber types were employed in this task and by the end of the war RAF Coastal Command had used Handley Page Halifaxes and American Boeing B-17 Fortresses and Consolidated B-24 Liberators in the very long-range role. The close of hostilities however, did not mean the end of the RAF's commitment to these duties because the creation of NATO ensured that long-range ocean patrol and air-sea rescue was just as vital as before. To replace the American types a maritime adaptation of the Lancaster was brought into service (and served until 1956) but there was a need for an all-new aircraft specially dedicated to this task.

Avro 696 Shackleton

The result was this development of Avro's Lincoln bomber (Chapter 7) and Tudor airliner and the first brochure was dated 29th January 1946. It described an aeroplane composed of the Tudor's outer wings and undercarriage, a modified Lincoln wing centre section, a Lincoln tail unit, plus a new fuselage that was deeper and wider than before. One 12,000lb (5,443kg) or a mix of smaller bombs could be carried and power would be supplied by four Merlins to give a top speed of 300mph (483km/h) at 18,300ft (5,578m). The project was selected for RAF Coastal Command service (there is no evidence of any competing designs) and R.5/46 was written around it. As built the 696 had a tail and fin slightly modified from the Lincoln arrangement plus four Griffon 57s with contra-rotating propellers. The first prototype flew on 9th March 1949 and the aircraft entered service in April 1951 as the Shackleton. A grand total of 191 Shackletons were built in three versions and the type served until the early 1990s.

Flying Boats – Estimated Data

Project	*Span ft in (m)*	*Length ft in (m)*	*Gross Wing Area ft² (m²)*	*Max Weight lb (kg)*	*Engine hp (kW)*	*Max Speed / Height mph (km/h) / ft (m)*	*Armament*
Saro S.36 Lerwick (flown)	80 10 (24.6)	63 8 (19.4)	845 (78.6)	28,400 (12,882)	2 x Hercules HE.1.SM 1,375 (1,025)	214 (344)	4 x 500lb (227kg) or 8 x 250lb (113kg) bombs or 4 depth charges, 7 x 0.303in mgs
Short Sunderland Mk.I (flown)	112 9 (34.4)	85 7 (26.1)	1,488 (138.4)	56,000 (25,402)	4 x Pegasus XXII 1,010 (763)	209 (336) at 5,000 (1,524)	2,000lb (907kg) bombs or depth charges, 7 x 0.303in mgs
Short Seaford Mk.I (flown)	112 9.5 (34.4)	88 7 (27.0)	1,488 (138.4)	75,000 (34,020)	4 x Hercules XIX 1,700 (1,268)	242 (389)	2,000lb (907kg) bombs or depth charges, 2 x 20mm cannon, 2 x 0.303in (7.7mm) plus 6 x 0.5in (12.7mm) mgs
Specification R.5/39 & R.14/40							
Blackburn B.32	102 0 (31.1) floats up 95 6 (29.1) floats down	85 7 (26.1)	1,650 (153.5)	For 1,500 miles range 52,500 (23,814) norm 65,428 (29,678) o'load 53,550 (24,290) norm 66,778 (30,291) o'load	4 x Hercules HE.7.SM 1,580 (1,178) or 4 x Griffon 1,600 (1,193)	299 (481) at 15,000 (4,572) 304 (489) at 15,000 (4,572)	6 bombs, 5 x 20mm cannon
Saunders-Roe S.38	110 0 (33.5)	97 0 (29.6)	1,640 (152.5)	54,935 (24,919) norm 68,885 (31,246) o'load 55,467 (25,160) norm	4 x Hercules HE.1.SM or Griffon	284 (457) or 291 (468) at 15,000 (4,572)	bombs (up to 4,000lb [1,818kg]?) 5 x 20mm cannon
Short R.5/39	115 6 (35.2)	94 0 (28.7)	1,788 (166.3)	For 1,500 miles range 60,700 (27,534) norm 71,800 (32,568) o'load 61,850 (28,055) norm 73,290 (33,244) o'load	4 x Hercules HE.7.SM or Griffon	279 (449) at 15,000 (4,572) 273 (439) at 8,600 (2,621)	bombs (up to 4,000lb [1,818kg]?) 20mm cannon
Supermarine 328	97 0 (29.6)	82 9 (25.2)	1,360 (126.5)	For 1,500 miles range 49,890 (22,630) norm 63,690 (28,890) o'load 49,710 (22,548) norm 65,610 (29,761) o'load	4 x Hercules HE.7.SM or Griffon	323 (520) at 17,500 (5,334) 326 (525) at 17,500 (5,334)	4,000lb (1,814kg) bombs, 4 x 20mm cannon
Saunders-Roe S.39	137 0 (41.8)	105 0 (32.0)	2,200 (204.6)	80,000 (36,288) norm 96,000 (43,546) o'load	4 x Centaurus	300 (483) at 15,000 (4,572)	bombs, 4 guns
Short Shetland Mk.I (flown)	150 4 (45.8)	109 11 (33.5)	?	130,000 (58,968)	4 x Centaurus VII 2,150 (1,603)	267 (430)	18,000lb (8,165kg) bombs, 2 x 20mm cannon, 10 x 0.5in (12.7mm) mgs
Specification R.13/40							
Blackburn B.40	98 0 (29.9)	?	1,400 (130.2)?	52,500 (23,814)	2 x Centaurus 2,080 (1,551)	c245 (394) at 5,000 (1,524)	bombs, 1 x 20mm cannon, 4 x 0.5in (12.7mm) and 4 x 0.303in (7.7mm) mgs
Specification R.2/48							
Saunders-Roe P.104	134 0 (40.8)	105 0 (32.0)	1,664 (154.8)	89,900 (40,779)	4 x compounded Griffon RGT.30.SM	290 (467) at 10,000 (3,048)	Pentane, bombs, mines and RPs, 2 x 20mm cannon
Short Brothers P.D.2	155 0 (47.2)	97 10.5 (29.8)	2,132 (198.3)	105,000 (47,628) or 107,000 (48,535)	4 x Nomad or Centaurus 661	326 (525) or 299 (481) at 10,000 (3,048)	Pentane, bombs, mines and RPs, 2 x 20mm cannon
Supermarine 524	148 0 (45.1) (floats ext'd)	98 0 (29.9)	2,190 (203.7)	106,400 (48,263) 117,100 (53,117) 103,200 (46,812)	4 x Centaurus 160 2,700 (2,013) or 4 x Proteus 3 3,400 (2,535) or 4 x Nomad 1,580shp (1,178) and 324lb (1.44) at sea level	326 (525) 389 (626) 381 (613)	4 x 2,000lb (907kg) Pentane, 8 x 1,000lb (454kg) or 16 x 500lb (227kg) bombs, 4 1,800lb (816kg) mines, 16 300lb (136kg) anti-sub bombs, 8 RPs, 2 x 20mm cannon
Avro 696 Shackleton Mk.I (flown)	120 0 (36.6)	77 6 (23.6)	1,421 (132.2)	82,000 (37,195)	2 Griffon 57 & 2 57A 2,450 (1,827)	294 (473) at 12,000 (3,658)	Up to 4,000lb (1,814kg) bombs, 2 x 20mm cannon

Chapter Nine

RAF and Fleet Air Arm Torpedo Bombers

The RAF operated shore-based torpedo bombers while the FAA employed both shore and carrier-based types. All of them have been grouped together under one chapter.

Fairey Swordfish

The Swordfish was easily the most famous of the Fleet Air Arm's wartime torpedo bombers and resulted from Specification S.15/33, which requested a general purpose spotter-reconnaissance and torpedo aircraft. Prototypes (all biplanes) were built by Blackburn (the Shark which also entered production), Gloster (the TSR.38) and Fairey. Fairey's prototype first flew on 17th April 1934 and the subsequent production order was covered by Specification 38/34. By the opening of the Second World War the Swordfish was considered rather out of date but it was to prove highly successful during the early years of the conflict and on several occasions covered itself with glory.

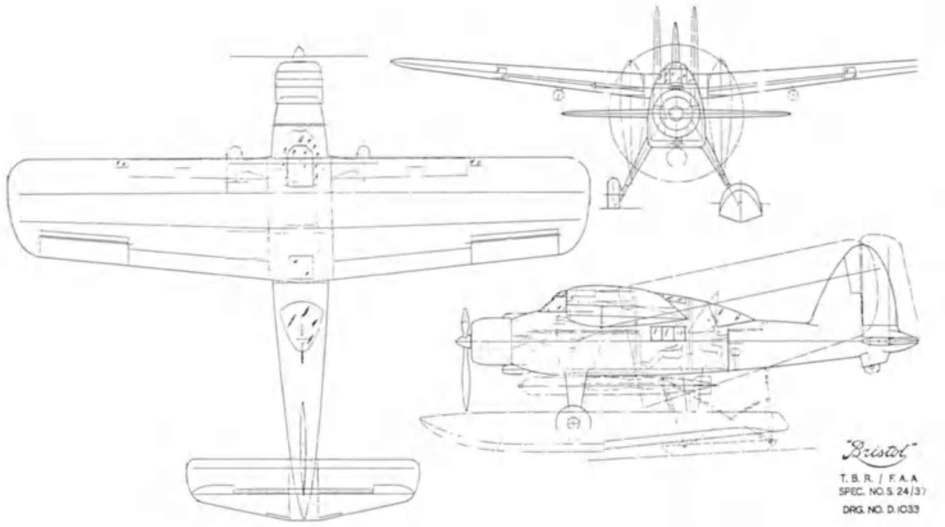
Fairey Albacore

The Albacore was a follow-on to the Swordfish and shared its biplane configuration, albeit with an enclosed cockpit, but it was never to acquire the fame of its predecessor. The initial design stemmed from Specification M.7/36 of 8th September 1936 which described a torpedo spotter reconnaissance aeroplane. This document was later cancelled but a replacement, 41/36, was produced in February 1937 to allow the project to be completed. It appears that no competition was forthcoming from any other company and the prototype, L7074, made its maiden flight on 12th December 1938. The first production aeroplanes entered service in 1940 and eventually 800 were built, but by the end of 1943 most of the squadrons using the type had moved on the more advanced aircraft like the Barracuda (below) and the American Grumman Avenger. In contrast to the Swordfish, the Albacore seems to be one of the more forgotten types that operated during the War.

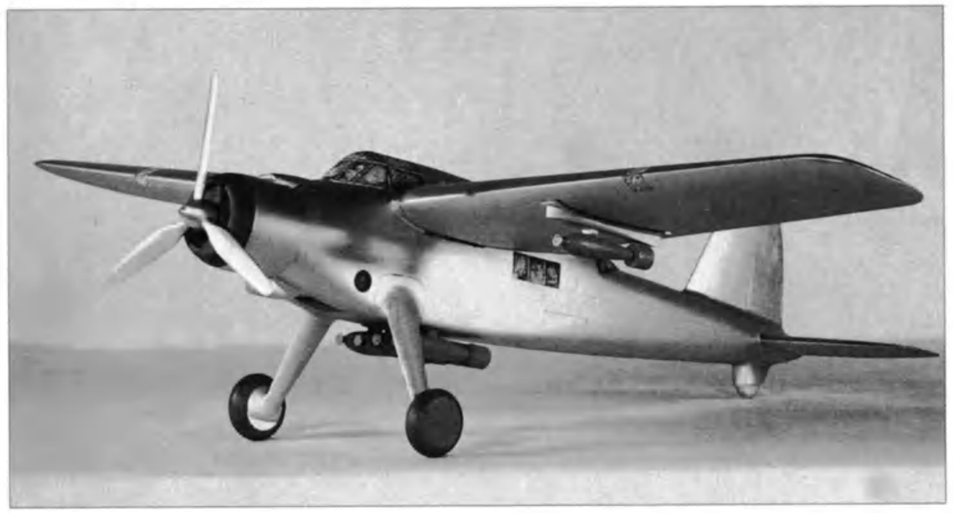
Opposite: **Short Sturgeon prototype RK787.** Short Bros.

Top: **Fairey Swordfish L9781 seen flying over HMS *Ark Royal*.**

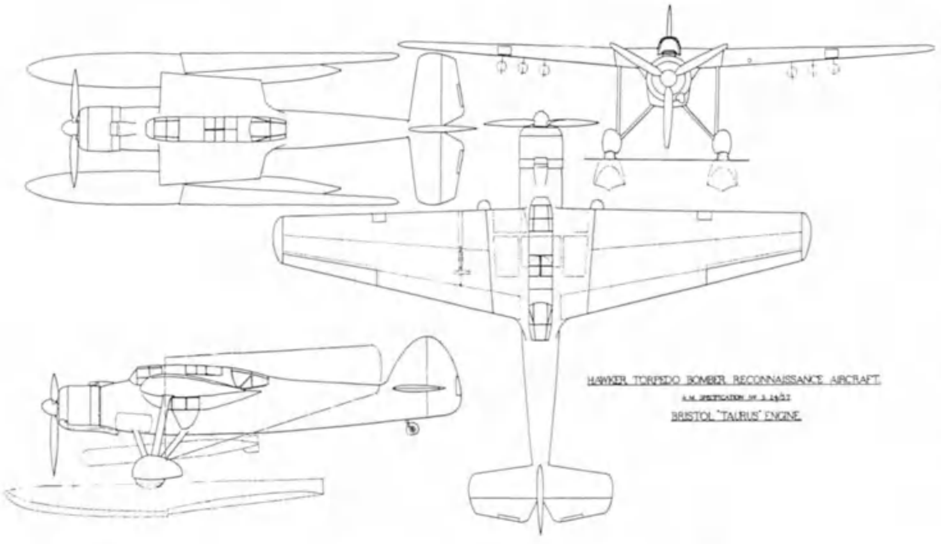
Above: **Fairey Albacore N4257.**



Bristol S.24/37 (8.3.38). The 'combined' drawing shows both ship and float versions. Jim Oughton



Centre: **Model of the Bristol S.24/37.** Jim Oughton


HAWKER TORPEDO BOMBER RECONNAISSANCE AIRCRAFT.
A.M. SPECIFICATION No S.24/37
BRISTOL "TAURUS" ENGINE.

'Combined' drawing of ship and float versions of the Hawker S.24/37 (3.3.38). Chris Farara, Brooklands Museum

Specification S.24/37, Fairey Barracuda and Supermarine 322

In July 1937 two private venture 'TSR Replacement' designs submitted to DTD by Blackburn and Fairey were discussed at the Ministry (details have not been traced but they were probably intended to replace the Swordfish). Fairey's layout had a low wing, Blackburn's a high wing and, since the Admiralty held strong views on high wings, Fairey's low wing could be ruled out. Blackburn's was thought to be 'on the right lines' but it was based on requirements produced about a year previously and, at this stage, a cruise speed of 200mph (322km/h) was considered 'scarcely adequate for an aircraft not likely to be flying until about 1939'. (It is worth noting that the Swordfish's top speed in 1940 was only around 140mph [225km/h], but few could have predicted how long that aircraft would last.) Fairey's rejected low-wing design used two of its own P.24 engines and had an all-metal monocoque structure and two crew; a big feature was a 'high-speed' wing fitted with an early version of the Fairey-Youngman flap. However, the Ministry did not like the idea of twin-engined aircraft operating from carriers and so new requirements were drawn up, which became Specification S.24/37 of 6th January 1938.

S.24/37 requested a carrier-based torpedo bomber, dive bomber and reconnaissance aircraft all in one. Maximum all-up-weight had to be 10,500lb (4,763kg), including one 1,500lb (680kg) torpedo or three 500lb (227kg) or six 250lb (113kg) bombs. An alternative float undercarriage for use in sheltered waters was to be provided in the design but was not required to be constructed (this was later dropped) and in February the document was sent to six companies. The following tenders were submitted.

Blackburn B.21, B.29 and B.36

The design actually tendered to S.24/37 was probably the B.29. The B.21 was drawn in 1937 but was dropped in favour of the B.29 high-wing monoplane project, for which Blackburn built a mock-up. The design was seen as a replacement for the Shark torpedo bomber; it had a high sided fuselage and a single fin and was to be powered by a Rolls-Royce Exe (which was originally called the Boreas). After Blackburn's S.24/37 proposals had been rejected a further scheme to S.24/37 called the B.36 was completed which was dated 16th June 1938.

Bristol S.24/37

This high-wing cantilever monoplane project was to be powered by a single Bristol Taurus and could carry the torpedo, or four of the bombs, under the fuselage; a single bomb could also be loaded under each wing. There were two 115gal (523lit) fuel tanks, one to each side of the fuselage, and the folded span was just 12ft 0in (3.7m), the wings folding backwards from the roots. Three crew were carried and, for defensive purposes, a single Vickers 'K' gun was mounted in the rear cockpit.

Fairey Type 100

This had a shoulder wing arrangement and was powered by a 1,200bhp (895kW) Exe.

Hawker S.24/37

Another shoulder-wing Taurus-powered design, this carried its torpedo beneath the fuselage but all of the bombs went under the wings, three per side. Again the wings folded rearwards a little outside the roots (folded width 13ft 6in [4.1m]) and approximately 200gal (909lit) of internal fuel were carried. A single 0.303in (7.7mm) Browning machine gun was housed in the port wing.

Supermarine 322

This high-wing design could use the Exe (as drawn) or the Taurus and had its bombs recessed under the underside of the fuselage. There was a single forward-firing gun in the wing and the folded width was 13ft (4.1m). In the reconnaissance role the all-up-weight would be 10,500lb (4,763kg) and the service ceiling with the Exe was 26,000ft (7,925m); with the Taurus 27,400ft (8,352m). A novel feature was the variable-incidence wings which, because they offered desirable low-speed characteristics, were seen as a solution to the problem of increasing the angle of descent and reducing the landing run of a 'clean' carrier-based torpedo aircraft.

Westland P.10

Another to employ the Taurus, this layout had a braced high wing with a tailwheel landing gear.

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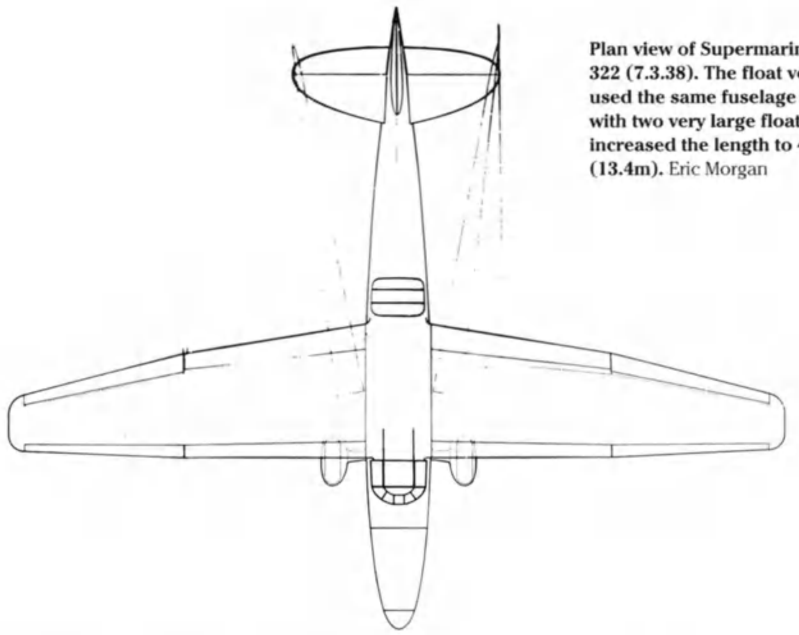
The Tender Design Conference was held on 31st March 1938. Fairey's design was considered the best while Blackburn's was 'inferior' and it was agreed to recommend Fairey, eliminate Blackburn and then reconsider the other four in order to choose an alternative to Fairey. The designs were powered either by the Bristol Taurus radial or the Rolls-Royce Exe air-cooled in-line unit and, at this point, the Taurus was a little ahead of the Exe in development, but both were expected to be available at the same time; the power ratings were similar but the Exe was heavier (work on the Exe was suspended in December 1939). Back at the conference Bristol's project was eventually deleted and Supermarine's was considered to be too experimental, so it was decided to recommend that a contract should be placed with Fairey for two or three prototypes while Hawker and Westland should be informed of the drawbacks to their designs and be invited to submit revised proposals with a view to one of them being ordered as a prototype.



Plan view of Supermarine Type 322 (7.3.38). The float version used the same fuselage fitted with two very large floats which increased the length to 44ft 0in (13.4m). Eric Morgan

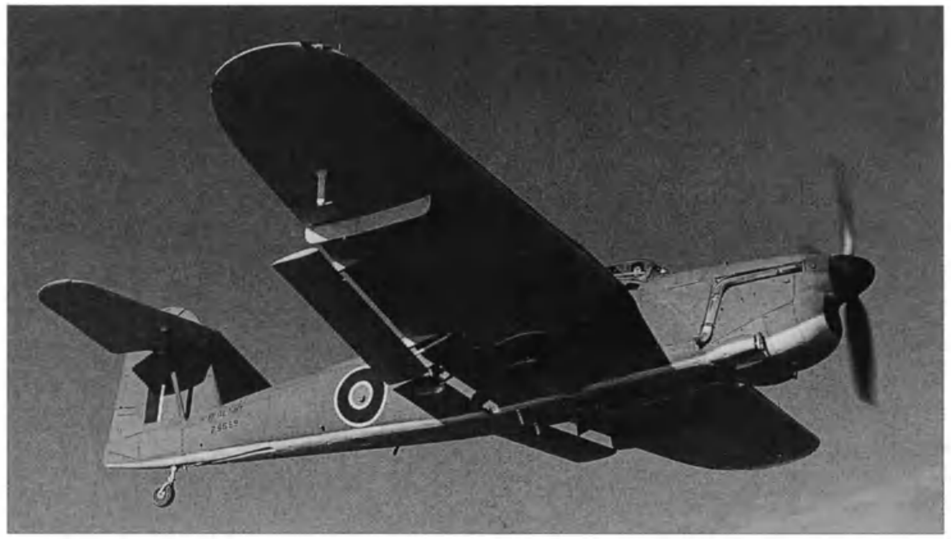
Their revisions were assessed at a further conference held on 16th May. DTD said that both were good and Westland was free to undertake the design effort but Hawker was about to begin work on a single-seat fighter to replace the Hurricane. No decision was taken but on 30th July the Admiralty declared that both projects used experimental features which were important to the FAA and so it wanted two prototypes ordered from each company. On 5th August Liptrot recommended that two prototypes should come from Hawker 'as a spur to Fairey', but ten days later the Air Ministry recommended placing an order with Fairey for four prototypes while both the Hawker and Westland designs should be reconsidered in January 1939.

Then, on 22nd September, it was learnt that Fairey had gone right ahead with its design while Hawker was very much behind, so there would be a delay of perhaps five or six months in getting a comparative prototype. It was also thought that it would be difficult to get Hawker really interested. By the end of the month Westland was out of the picture because it now had too much work in hand (the Lysander army co-operation aircraft and a fighter) whereas Hawker had not made much progress when Fairey had made a great deal. On 30th November 1938 the Admiralty commended to the Air Ministry that no further progress should be made with the Hawker and Westland proposals.

Fairey Barracuda

The prototype contract for the Fairey project was placed on 30th January 1939 and in February a production order for 300 examples was agreed. A Ministry document noted that the Exe had to be discarded but it was over two and a half months before it was finally decided to fit the Rolls-Royce Merlin. Replacing the Exe was a 1,250bhp (932kW) Merlin 30 which forced Marcel Lobelle, Fairey's chief designer, to redesign the aircraft. His answer was a low-wing type with the rest of the airframe not dissimilar to the final shape. Fairey also wished to use its own and far more powerful P.24 engine but the Merlin stayed.

In due course, to ensure that the requirements were met in full and to satisfy the CofG, the wing was pushed up to the shoulder position. Fitted with the low wing, and loaded with all of its equipment, the aeroplane would have fallen outside its safe operating envelope, so if the low wing was to be retained its leading edge would have to be moved forward and this would affect some of the pilot's view. Also the wing had to be foldable with the undercarriage fully retractable (on the Swordfish and Albacore the latter was fixed) and, to quote Bill Harrison in his *Fairey Barracuda* Warpaint 'Lobelle's design was, to say the least, quite brilliant in that he man-



Fairey Barracuda Mk.I P9659.

aged to incorporate the Ministry's requirements into an aeroplane overweight and underpowered'. The Barracuda was also fitted with large Fairey-Youngman flaps which, apart from their usual function, could be set at a negative angle of 30° to serve as dive brakes. The first prototype became airborne on 7th December 1940 and the type was eventually named Barracuda. Despite numerous development problems 2,600 were built, the first entering service in 1943 and the last lasting into 1953.

Supermarine 322 'Dumbo'

Despite its dismissal for being 'too experimental', in 1939 an order was placed for two Type 322 prototypes, R1810 and R1815, to test the variable-incidence wing, the fitting of which precluded a retractable undercarriage. However, Supermarine's Spitfire commitments meant that the first example (built entirely of wood) did not fly until 6th February 1943 but it was found that, despite the fixed undercarriage, the second prototype (with duralumin wings and the same 1,640bhp [1,223kW] Merlin 32) flew rather faster than the Barracuda Mk.II (240mph [386km/h] against 279mph [449km/h]). The 322 was nicknamed 'Dumbo'.

Bristol Beaufort/Blackburn Botha

This story brings together three different specifications and resulted in two different aeroplanes, one quite successful but the other less so. Specification M.15/35 requested a shore-based torpedo bomber while the G.24/35 called for a general purpose land-based reconnaissance aircraft and both were approved by DTD in September 1935 and issued to tender; later they were combined into 10/36. M.15/35 resulted in the following designs.

Avro 672

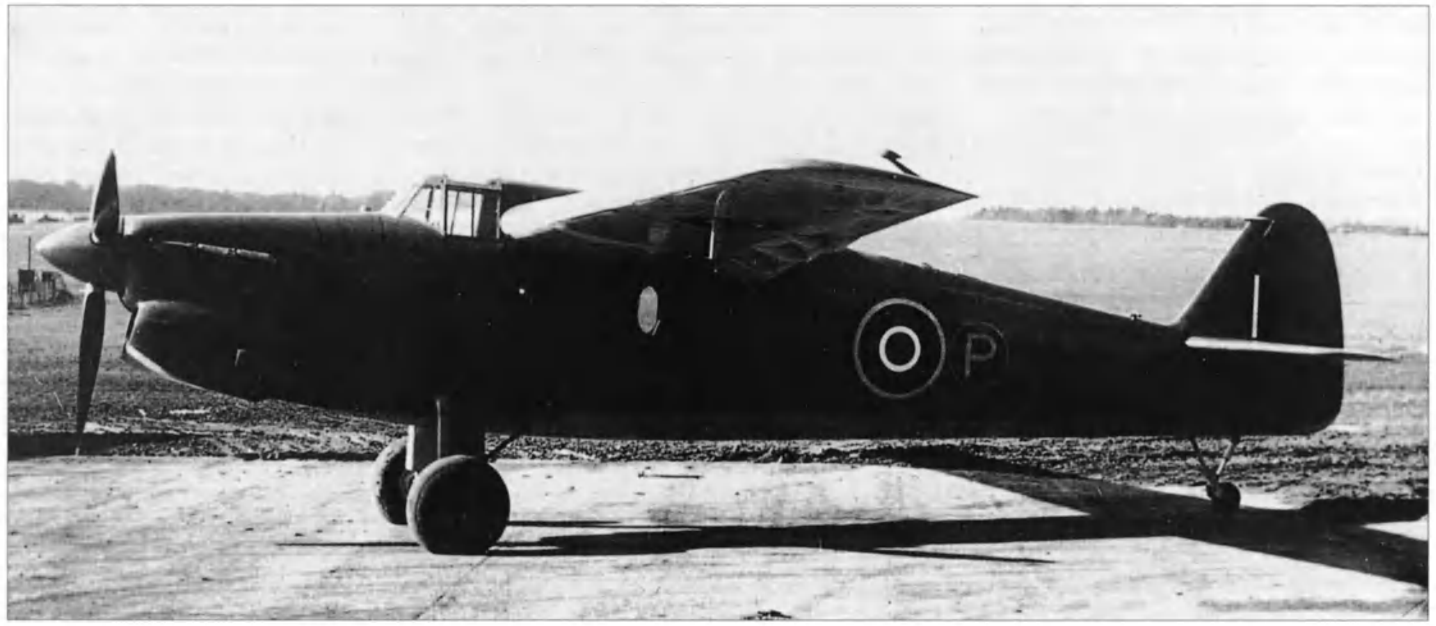
This was a much modified development of Avro's Anson reconnaissance and training aircraft first flown on 24th March 1935. It was powered by two Terrier engines and had a dorsal turret with two machine guns. Span was 59ft 8in (18.2m), length 45ft 2in (13.8m).

Blackburn M.15/35

An unnumbered high-wing design was submitted which used Armstrong Siddeley Terrier or Aquila engines.

Boulton Paul P.83

Fitted with either Bristol Pegasus X or Rolls-Royce Goshawks, this aircraft had an all-metal monocoque structure and carried four bombs or a single torpedo in a recess in the lower fuselage. A dorsal turret housed twin Lewis guns and one forward-facing 0.303in (7.7mm) Browning was mounted in the port fuselage side level with the pilot. The Goshawk variant required 413gal (1,878lit) of fuel while the Pegasus pushed this up to 457gal (2,078lit), but the two engines gave a near identical performance including a 2,000ft/min (610m/min) rate of climb at sea level and 28,000ft (8,534m) service ceiling.



Supermarine Type 322 'Dumbo' prototype R1810. Eric Morgan

Bristol 150

Similar in most respects to Bristol's Type 142M (Blenheim) medium bomber, and the company's G.24/35 project, the only differences were those necessitated by M.15/35's requirements for equipment or strength. For example the cabin was wider and longer to allow, respectively, more comfortable navigation and for the torpedo to be stowed internally; in fact an extra 4ft 6in (1.4m) of cabin had been added between the front spar and the pilot's seat. The rear turret was identical to the G.24/35 and the single fixed Browning gun in the starboard wing and the bomb cells were the same as the 142M. Maximum rate of climb was 2,070ft/min (631m/min) at 5,000ft (1,524m) and service ceiling 26,500ft (8,077m).

Handley Page and Vickers

Both companies converted their B.9/32 medium bombers (the Hampden and the original Type 271 'Wellington' prototypes) to M.15/35.

A Tender Design Conference, held on 8th January 1936, described Blackburn's armament scheme as excellent, particularly the torpedo and bomb installation, and noted that a high wing specially suited the requirement. Bristol's Perseus was not very good and the Handley Page and Vickers conversions were both too big, but these did show that it was quite possible for a medium bomber to carry an alternative torpedo without an adverse effect on its design. The following G.24/35 designs were actually submitted ahead of the M.15/35 projects and their Tender Design Conference was held on 10th December 1935.

Avro 675

A further development of the Anson, again powered by Terriers (the Aquila was an alternative), but featuring a nose observer's position plus a long glazed cockpit roof. Span 50ft 6in (15.4m), length 42ft 6in (13.0m).

Blackburn G.25/35

No information survives on this Aquila-powered machine but the Tender Conference rated it as good.

Boulton Paul P.84

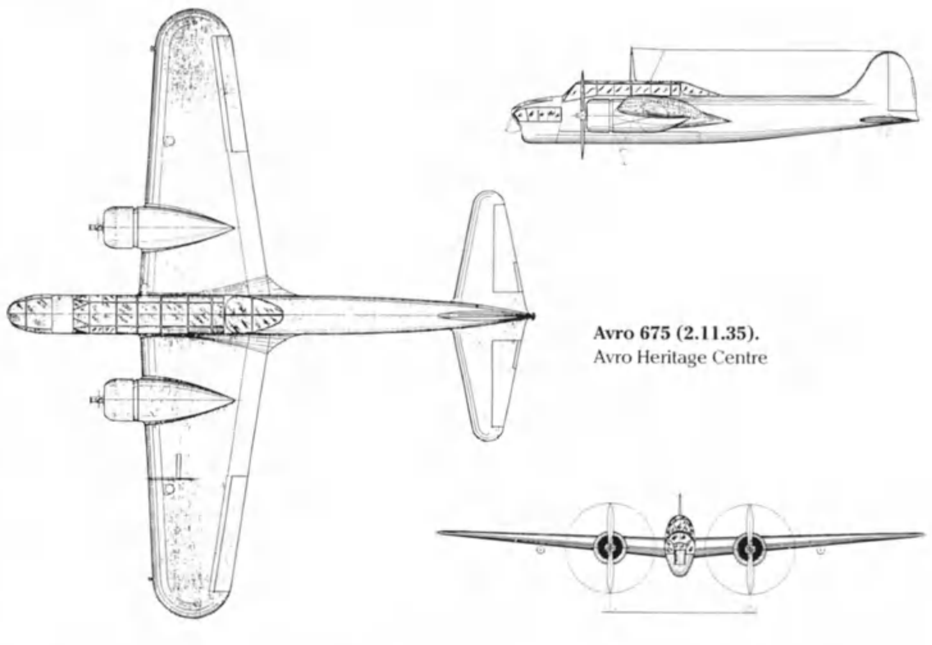
This was a near identical aeroplane to the P.83 and shared interchangeable wings, tail unit, undercarriage and (derated Goshawk) engines; the principal differences were small changes to the body layout, a slightly lower weight and reduced internal fuel. An alternative engine was the Aquila AE.3.M radial which also required a smaller wing, had a slightly shorter tail (but the same body), carried less fuel (297gal [1,350lit] against 317gal [1,441lit]) and gave a sea level rate of climb of 1,750ft/min (533m/min) when the Goshawk offered 2,000ft/min (610m/min); service ceilings were 25,500ft (7,772m) and 26,500ft (8,077m) respectively. The gun and bomb carrying arrangements were unchanged from the P.83. G.24/35 specified a maximum all-up-weight of 9,500lb (4,309kg) but Boulton Paul had concluded that the range and performance could not be met within this limit.

Bristol G.24/35

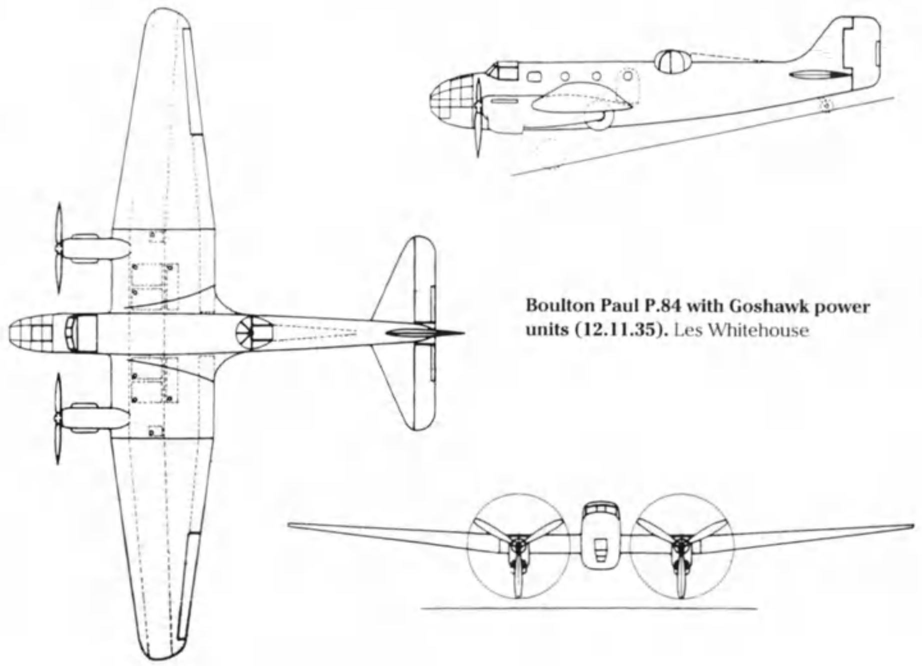
This aircraft was another conversion of the 142M with a wider cabin and a larger rear turret but with the same bomb cells and fixed Browning gun. Sea level rate of climb was 1,613ft/min (492m/min) and service ceiling 26,200ft (7,986m).

Gloster G.24/35

No details available.



Avro 675 (2.11.35). Avro Heritage Centre



Boulton Paul P.84 with Goshawk power units (12.11.35). Les Whitehouse

Westland G.24/35

A project with two Perseus engines, recesses for four 500lb (227kg) bombs or two torpedoes on either side of the lower fuselage (described at the conference as a 'novel feature') and a dorsal turret. Span was 57ft 0in (17.4m) and wing area 475ft^2 (44.2m^2). The conference declared that neither Gloster's or Westland's proposals were acceptable.

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The Air Ministry had thought that the most that could be done with these specifications was to produce a single basic design that could be converted at some stage of production to either of the two different types. However, Bristol's Leslie Frise had always envisaged making a single aircraft type that would combine the functions of general reconnaissance and torpedo bombing and he pressed these ideas on the Air Ministry. The two Bristol designs described above were both Blenheim developments that were intended to use some of the same parts. Frise felt that Squadron Leader Oxland was a great stumbling block to this, declaring that he had no vision and was always thinking of details. Nevertheless, in December 1935 the Air Staff discussed the prospects of such a union and concluded that it would be possible for both of these roles to be combined in one class of aircraft.

On 14th January 1936 DTD recommended merging the two specifications and ordering duplicate prototypes from Avro, Blackburn and Boulton Paul. On 26th January CAS agreed that Avro, Blackburn, Boulton Paul and Bristol, who had all submitted good designs, should be asked to submit new projects that merged the two requirements and this was the direction that was taken. The resulting designs were discussed individually with their companies during January and February 1936 and in March CAS decided to amalgamate the two documents, at the same time giving approval for production orders 'off the drawing board' to both Blackburn and Bristol. The new specification, 10/36 approved in June, contained some revisions including a speed with a normal weapon load of 220mph (354km/h) at 15,000ft (4,572m) and a range with a 1,000lb (454kg) load of 1,250 miles (2,011km).

Avro 10/36

This appears to have been a revision of the Type 675.

Blackburn B.26

This was ordered as the Botha and the first production example, which doubled as a prototype, made its maiden flight on 28th December 1938. However, its Perseus engines gave insufficient power and in October 1940, after a brief career, it was decided not to use the type as an operational aircraft any longer. A total of 580 were built (over 670 were cancelled) and most were used for training.

Boulton Paul P.86

This aircraft was identical to the Aquila-powered P.84 except that it had a longer nose, extra observation windows, alternative torpedo accommodation and increased tankage to cope with the longer range limit; these additions added 120lb (54kg) to the weight and reduced the maximum speed by about 2mph (3.2km/h). In the general reconnaissance role the service ceiling would be 32,000ft (9,754m), as a torpedo bomber 29,000ft (8,839m).

Bristol 152

On 21st February 1936 Bristol completed a brochure for a design which was much altered from its previous studies. The body length ahead of the wings was increased but the fixed forward-firing gun was still as per the 142M and a dorsal turret was still in place. There was permanent tankage in the wings for 415gal (1,887lit) of fuel and construction was all-metal, the wings being covered in Alclad. The general reconnaissance version could carry the required bomb loads – one 2,000lb (907kg), two 500lb (227kg) or four 250lb (113kg) – and the only change for the torpedo role concerned the body floor for loading the 1,900lb (862kg) torpedo, the weapon being slung with half of its diameter protruding. At a late stage of the airframe's construction the necessary modification would be made to suit either type. Alternative powerplants were the Perseus or Aquila which gave respective sea level rates of climb 2,000ft/min (610m/min) and 1,670ft/min (509m/min), and service ceilings 27,000ft (8,230m) and 26,500ft (8,077m). The initial production order was placed on 22nd August 1936.

Bristol 152 Beaufort

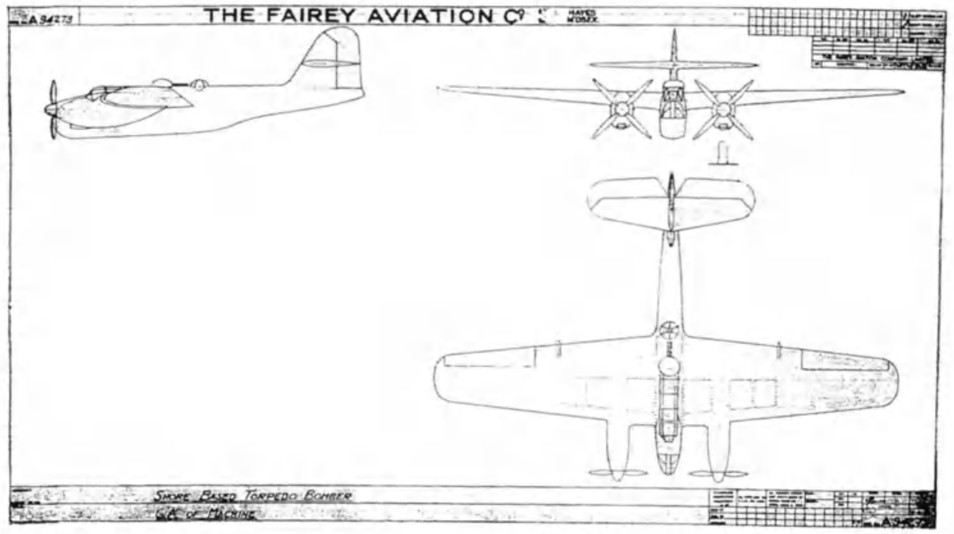
Bristol and Blackburn were the only companies to build aeroplanes to 10/36. Although originally intended to meet the one document and to use Perseus engines, the Botha's structural weight was 2,000lb (907kg) more than the Bristol design, which was later named Beaufort. In early 1937 the Air Staff changed its requirements and decided that bombing should now be the type's primary role, which meant that the aircraft would now have to operate at 15,000ft (4,572m) instead of 5,000ft (1,524m). Since the planned engine for the Beaufort was only moderately supercharged, a fully supercharged alternative was introduced to allow cruise at 15,000ft. At about the same time the engines themselves were changed because Bristol felt that the Perseus had no development potential and in July 1937 permission was given to switch to the company's new engine, the Taurus. Blackburn stayed with the Perseus and the Botha suffered accordingly.

Construction of the first production aircraft was accelerated so that it could act as a prototype while the airframes following were purposely retarded to allow all necessary alterations and modifications to be incorporated. However, progress was slow and compared unfavourably with the Botha, whose Mock-up Conference took place in January 1937. By the following April the Beaufort mock-up was only two-thirds complete and its Conference finally took place in September. The mock-up included a four-gun turret but Oxland told Bristol to take that out and replace it with a single Lewis gun because it appeared that Browning production would be insufficient to satisfy every aircraft type that needed it. The first Beaufort, L4441, was much delayed and did not get airborne until 15th October 1938, but part of the problem was that Bristol was also preparing the Beaufighter (Chapter 2) to follow closely behind the Beaufort. The first true production Beaufort was delivered in October 1939 and eventually over 1,100 were built, later examples receiving American Pratt & Whitney Twin Wasp radial engines.

Production Blackburn Botha L6264.

The 'prototype' Bristol Beaufort L4441.

Beaufort Mk.Is N1172 and L9834 of No 42 Squadron in a picture released in May 1941.



The only known drawing of the Fairey Shore-Based Torpedo Bomber, twin Merlin 32s (9.4.42).

Specifications S.6/43 and S.11/43 Short Sturgeon

Fairey Shore-Based Torpedo Bomber

This unsolicited work does not appear to have been prepared against any specific requirement. A brochure was completed on 8th April 1942 for a machine powered by two Merlin 32s and armed with two 0.5in (12.7mm) Colt machine guns in an upper turret, one 0.5in lower rear gun, two 0.303in (7.7mm) Browning machine guns in the nose and one 21in (53.3cm) torpedo carried in a fuselage bay. It carried 450gal (2,046lit) of fuel, had a top speed of 210mph (338km/h) at sea level and would take 9 minutes to reach 10,000ft (3,048m) and 27.5 minutes to 20,000ft (6,096m); service ceiling was 21,750ft (6,629m) and range 840 miles (1,352km). An extra 300gal (1,364lit) could be carried to give an overload weight of 28,205lb (12,794kg) and a range of 1,500 miles (2,414km). On 12th July a second brochure described a revised version with two 1,980bhp (1,476kW) Griffon 61s, all-up-weight 34,100lb (15,468kg), maximum speed 279mph (449km/h) at 5,000ft (1,524m), time to 5,000ft 4.5 minutes, normal range 1,500 miles and overload range 2,000 miles (3,218km).

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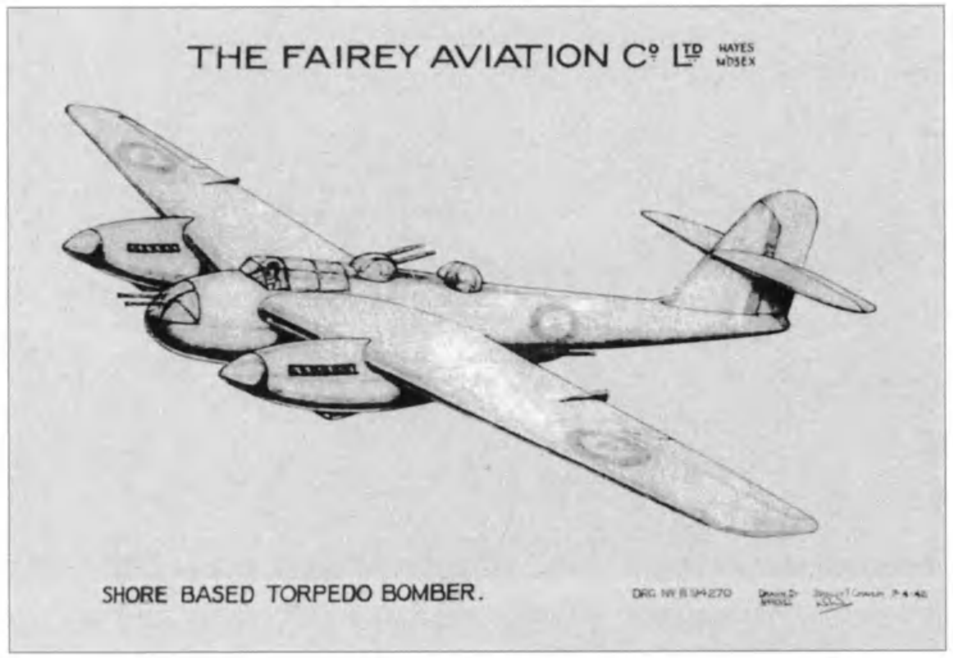
During the first months of 1943 the Admiralty began putting together S.6/43 for a torpedo bomber and reconnaissance aircraft, which included a maximum all-up-weight of 24,000lb (10,886kg) and overall length 46ft (14.0m). Design studies were requested from Armstrong Whitworth, Cunliffe-Owen, de Havilland (who were unable to comply), Fairey and Westland. Before the studies were


THE FAIREY AVIATION Cº LTD HAYES MDSEX
SHORE BASED TORPEDO BOMBER.
DRG. Nº B 94270

Poor quality but unique impression of the Fairey twin Merlin torpedo bomber.

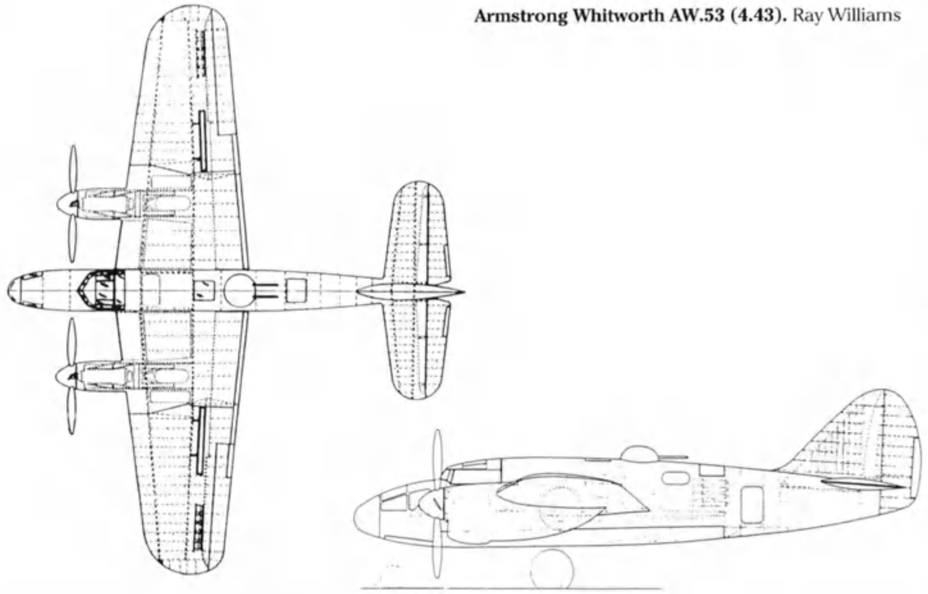
received CNR (Chief Naval Representative), in the light of advance information from the companies concerned, was able to forecast that, in general terms, a twin-engined aircraft to meet S.6/43 was unlikely to weigh less than 26,000lb (11,794kg) but a top speed of 300mph to 340mph (483km/h to 547km/h) might be possible. On the other hand a single-engine type would be lighter but, inevitably, would have a disappointing performance that would be little better than the Barracuda.

Therefore, at a Design Committee meeting held on 27th March, it was accordingly decided to split the functions and draft requirements were begun for i) a torpedo bomber and ii) a reconnaissance bomber with recce as its primary function. The former became O.5/43 and was to lead to the Fairey Spearfish described later; the latter became S.11/43. The S.6/43 proposals, however, were not cancelled since it was felt that they should be examined with a view to confirming the decision. These were as follows:

Armstrong Whitworth AW.53

AWA declared that the weight and length limits could not be met. The latter would certainly not provide sufficient yawing movement to counteract the effect of losing one engine, particularly during take-off, and even with a large fin and rudder the length could not be kept below 48ft (14.6m). The defensive armament comprised twin 0.5in (12.7mm) machine guns in a mid-upper turret and the offensive load, carried in an internal bomb bay, could be a torpedo or up to six 500lb (227kg) bombs; four rocket projectiles could also be loaded under each wing. Sea level top speed was 288mph (463km/h) and rate of climb fully loaded 1,280ft/min (390m/min); less the torpedo and half fuel this became 1,820ft/min (555m/min).

For the approach, Fowler flaps were fitted which moved backwards for 15% of the wing chord, while both ailerons were drooped to give the effect of full-span flaps. When the ailerons were in this position, differential gearing automatically came into action which ensured that the control remained light in operation. To counteract the adverse yawing moments due to drooped ailerons, a spoiler was automatically coupled to the control system, but this was inoperative when the ailerons were in their normal position. A tricycle undercarriage was provided with an exceptionally long vertical travel that would absorb the kinetic energy of landing with a vertical velocity of 17ft/sec (5.2m/sec); AWA's experience with the Albemarle gear had been very beneficial here. A laminar flow wing had been rejected but, to ensure a smooth surface free from dimples, the light alloy wing covering was fairly thick. Orthodox construction with light alloy sheeting was used throughout, except for the three fabric-covered control surfaces. The outer wings folded backwards on an inclined hinge at the rear spar and the arrester gear comprised a hook attached to the fuselage underside.



Armstrong Whitworth AW.53 (4.43). Ray Williams

Cunliffe-Owen S.6/43

No details are available but this machine weighed about 25,000lb (11,340kg) and the Admiralty noted that it was 'over-span and made poor provision for the observer's view'.

Fairey S.6/43

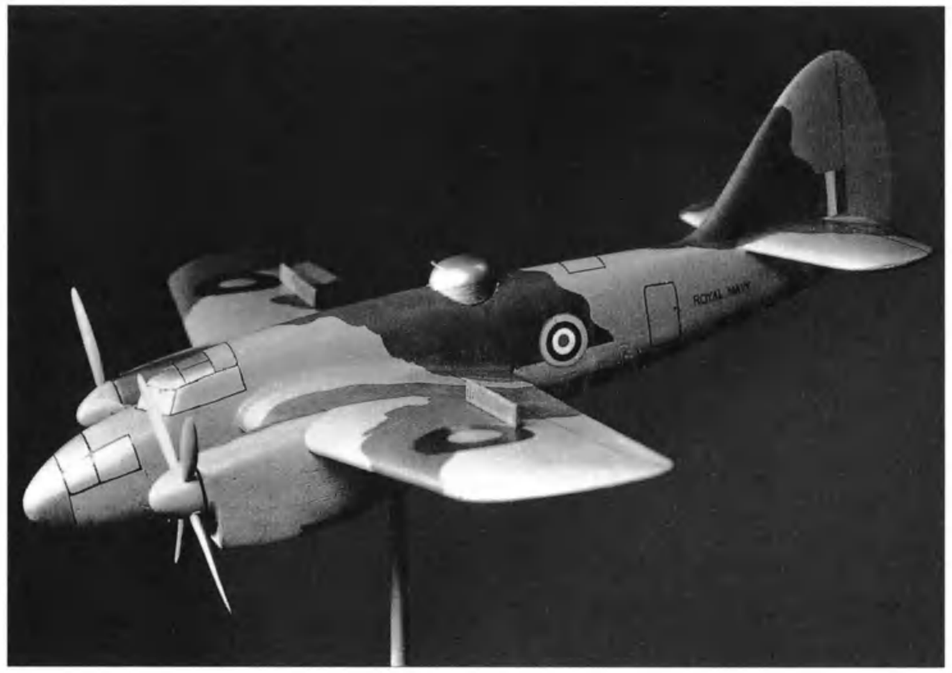
Fairey had explored both of the main alternatives to meet the requirements, either single or twin-engined tractor monoplanes, and had concluded that the single-engined type would virtually be a development of the Barracuda. Such a project was currently being undertaken within the present dimensional limits of the Barracuda specification, but this limited the range and weapon load and so Fairey had concentrated on a twin which offered a greatly improved view for the observer and pilot, a better power/weight ratio, the ability to carry a higher wing loading and the possibility of getting home on one engine. The engines examined included the Hercules 12.SM and Griffon 14.SM, but the Merlin RM.14.SM had been chosen which offered 1,960bhp (1,462kW) on MS power and 1,840bhp (1,372kW) on FS. The Griffon 61 offered a considerable increase in weight but a handsome dividend in performance; the Hercules weighed the same as the Griffon but gave an inferior performance.

The powerplant included the main cooling radiator installed in the wing leading edge for low drag, with oil and intercooler radiators, while the air intake was placed in the nose of the power egg; the variable pitch propellers were to be reversible for braking the aircraft during torpedo or bombing attacks and full-span flaps were to be fitted based on the Youngman scheme. The outer wings were of all-metal two-spar stressed skin construction, the fuselage was light alloy monocoque throughout, eliminating the need for stringers, and the tail unit had a stressed skin all-metal structure with an all-metal fin. All of the offensive stores were housed within the fuselage to give a minimum cross sectional area and a centrimetric ASV scanner, covering an arc of 150° ahead, was installed in the extreme forward position of the observer's cockpit.

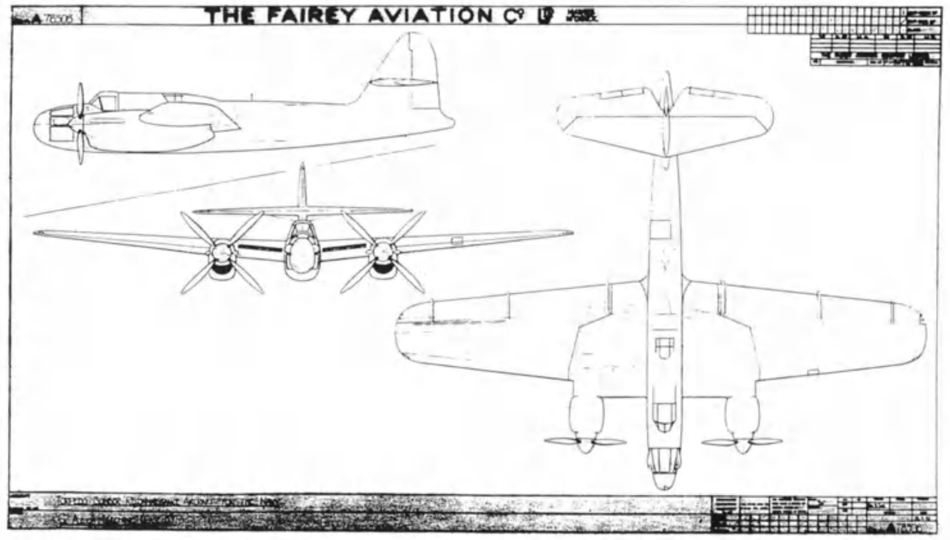
The rear defence comprised either two 0.5in (12.7mm) machine guns on a Rose type mounting or one 20mm cannon. At 25,670lb (11,644kg) weight, the maximum speed at sea level was 312mph (502km/h), time to 10,000ft (3,048m) 8.17 minutes and 20,000ft (6,096m) 17.33 minutes, service ceiling 29,400ft (8,961m) and normal range 900nm (1,667km). Internal fuel was 550gal (2,501lit) but this could be increased to 880gal (4,001lit) to give a range of 1,500nm (2,778km).

Westland S.6/43

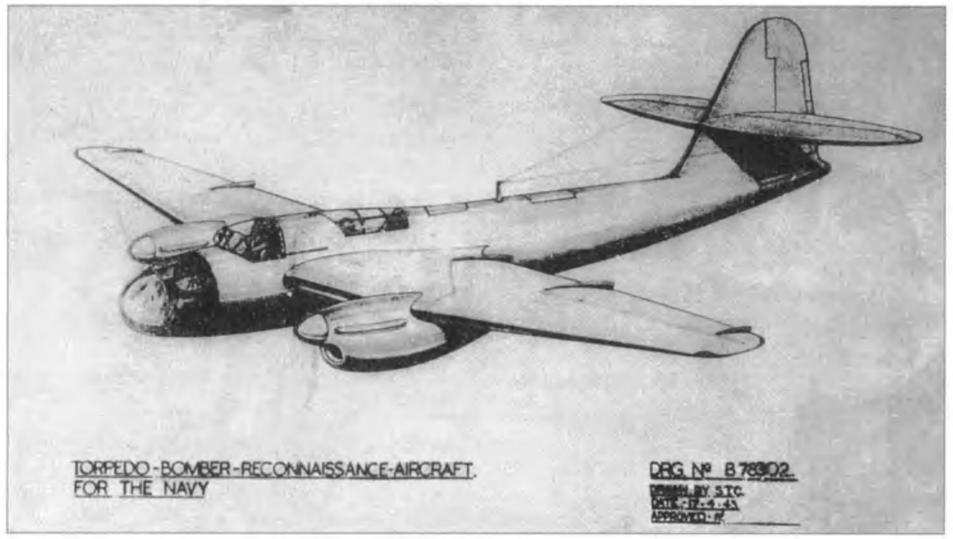
This was powered by a single Napier Sabre NS.53.SM and could carry a single torpedo or its bomb load internally in a lower fuselage bay (each of these S.6/43 designs could take an 18in [45.7cm], 21in [53.3cm] or 22.4in [56.9cm] diameter torpedo). Four rocket projectiles could be carried under each wing and



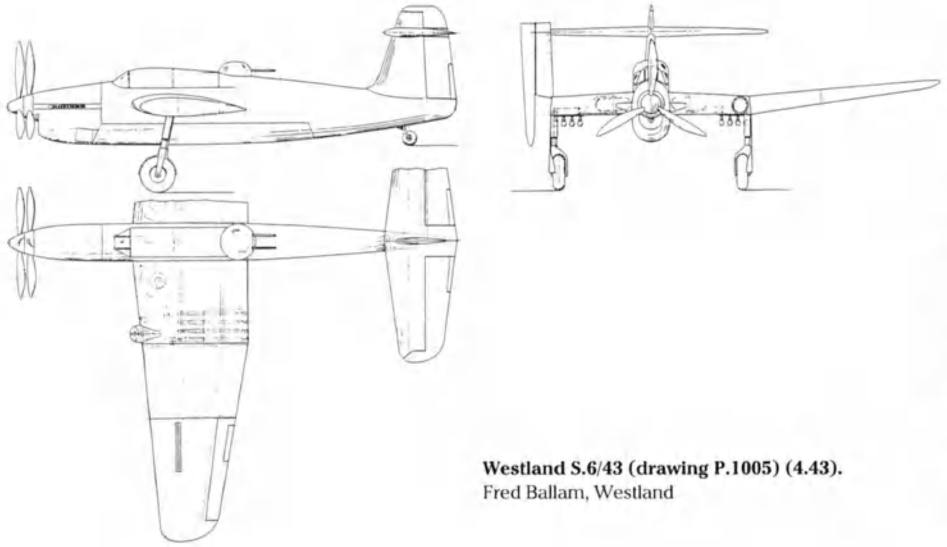
Model of the AW.53. Ray Williams



Fairey S.6/43 (17.4.43).


TORPEDO-BOMBER-RECONNAISSANCE-AIRCRAFT.
FOR THE NAVY
DRG. Nº B 78302.
DRAWN BY S.T.C.
DATE 17-4-43.
APPROVED

Impression of the Fairey S.6/43.

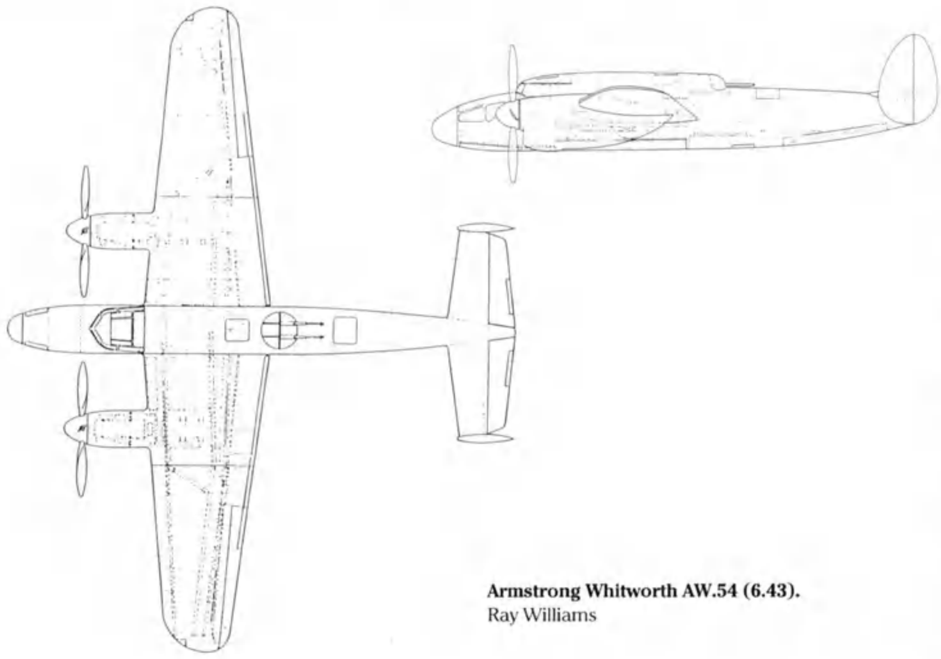


Westland S.6/43 (drawing P.1005) (4.43).
Fred Ballam, Westland

the wing folded in two positions from just outside the undercarriage position, which meant that the flaps came in two parts. A total of 400gal (1,819lit) of fuel were housed in each wing.

The AW.53 was described as 'a fair conventional effort' while, to comply fully with S.6/43, Fairey's project worked out at 27,200lb (12,338kg) and made use of somewhat experimental high-lift devices and control arrangements, but was still 'generally a fine attempt to meet the specification'. Under close examination its top speed (340mph [547km/h] at 17,000ft [5,182m]) would probably have been reduced since the brochure employed two Merlins in their highest projected stage of development and there was little doubt that, by the time the aircraft entered service, it would be close to the Admiralty's 30,000lb (13,608kg) limit. If the full specification was to be met Westland's single-engine machine would need an all-up-weight of 25,800lb (11,703kg); this design was based on the Sabre V and, even allowing that this engine would materialise, it would clearly have been overloaded.

These design studies confirmed the wisdom of abandoning the torpedo bomber reconnaissance aeroplane, although the Design Committee recognised the implications of departing from this 'maid of all work' type which had proved so successful. However, with an increase in the number of aircraft carriers expected to be available in the future, an increase in the number of aircraft types could now be more readily accepted than in the past, the prime objective here being to secure machines of generally better performance.



Armstrong Whitworth AW.54 (6.43).
Ray Williams

Shorts S.6/43

The book *Shorts Aircraft since 1900* states that during the summer of 1943 this company proposed two designs to S.6/43, but official documents make no mention of them. One was powered by a single Centaurus, the second by two Merlins, and the latter was the 'preferred' choice. The second design was certainly in the picture during the next stage, the reconnaissance bomber to S.11/43. The Staff requirements were sent to several companies and the Admiralty had little doubt that a high-performance three-seater, with a top speed in the 300/350mph (483/563km/h) zone, could be provided. It seemed certain that the highest performance would be offered by a twin-engined type.

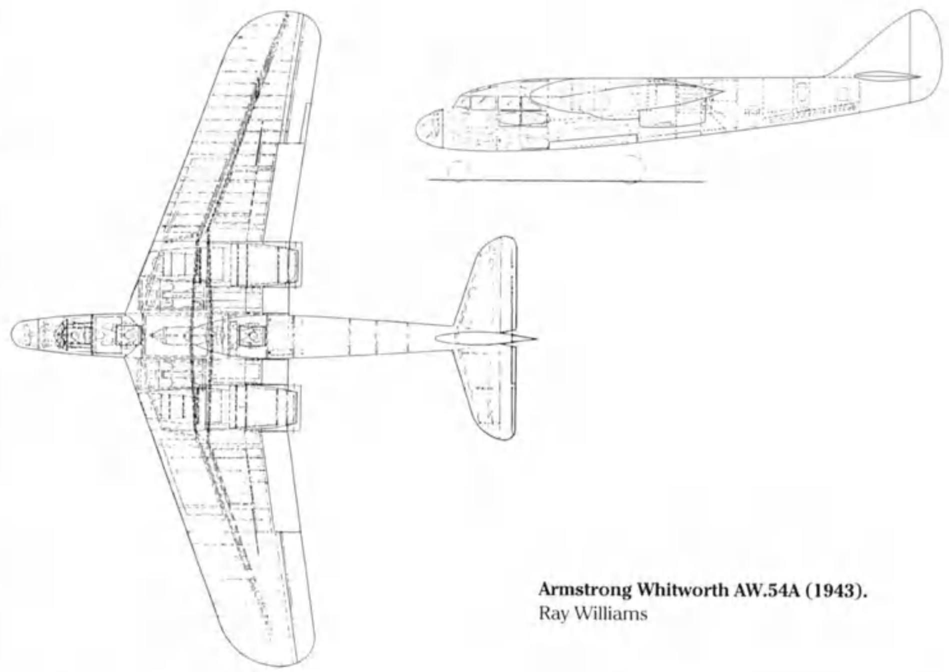
Armstrong Whitworth AW.54

This aircraft's general layout was similar to the AW.53, except that it was slightly smaller and had twin fins. AWA believed that it could design the aircraft to a weight not exceeding 20,000lb (9,072kg) but it would need a folded span of 27ft (8.2m). Top speed was 310mph (499km/h) at sea level and rate of climb 2,020ft/min (616m/min) at full load. Many of the features of the AW.53, such as the undercarriage, wing, Fowler flap and aileron arrangement, dorsal turret and the equipment for carrier operation, were retained but twice the specified bomb load (1,000lb [454kg]) could be carried. However, the design was criticised for lack its of performance and so AWA chief designer John Lloyd scrapped his piston proposals and switched to jet power.

Armstrong Whitworth AW.54A

This design introduced a much higher performance, particularly in regard to speed. It had swept laminar flow wings with two Metropolitan-Vickers F.3 engines (with augmented thrust) mounted on the trailing half just outboard of the roots; the wings, together with a reduced fuselage cross section, were intended to help the performance. The long-travel main gears had twin tyres and a variable-incidence tailplane was fitted so that any large change of trim caused by the flaps could be easily corrected. The flap/aileron combination used by the AW.53 and AW.54 for the approach was retained, except that slotted flaps were now fitted, and the main wings folded backwards on an inclined hinge.

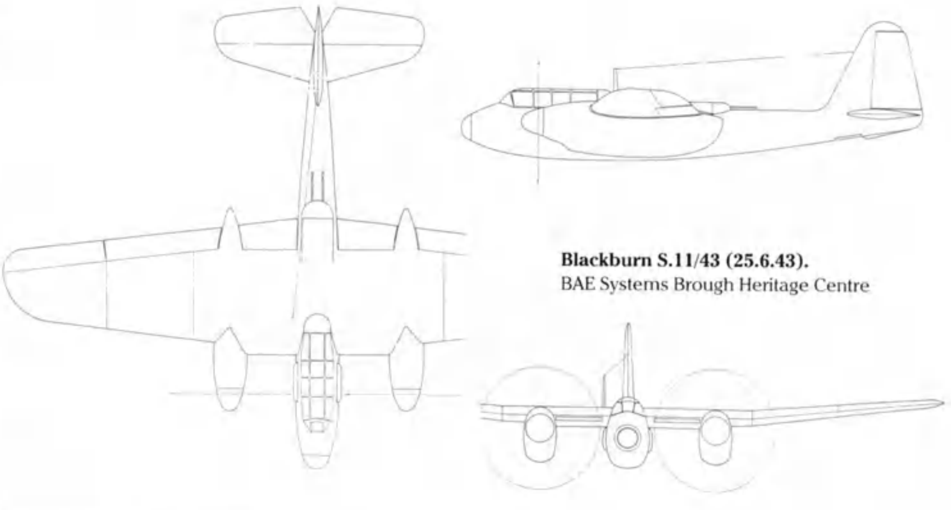
Thanks to its speed, defensive armament was thought to be unnecessary and was taken out. Top speed and rate of climb at sea level were 440mph (708km/h) and 4,300ft/min (1,311m/min) and, despite the known problems of high fuel consumption associated with jets, the 900nm (1,669km) range could be met using only the internal capacity. However, despite its promise, the proposal was turned down – the possible effects of jet efflux on aircraft carrier decks were, at the time, still uncertain and contributed to the decision.



Armstrong Whitworth AW.54A (1943).
Ray Williams

Blackburn S.11/43

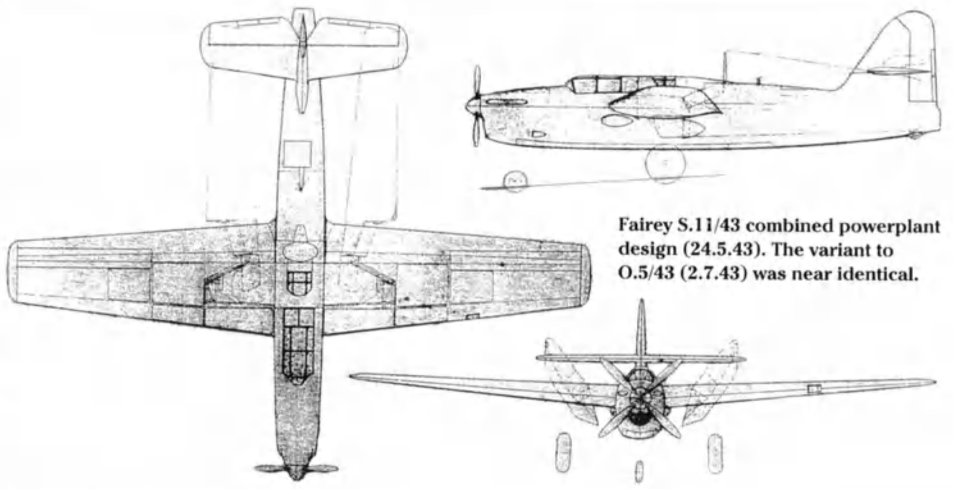
A drawing of this unnumbered project shows a twin dorsal turret and what looks like two Merlin engines. No data is available.



Blackburn S.11/43 (25.6.43).
BAE Systems Brough Heritage Centre

Fairey S.11/43

The main Fairey S.11/43 submission was made on 19th June 1943. As a design it was very similar to the July 1943 study made for O.5/43 (described below) and used a dual powerplant comprising a Merlin 26 plus a 3,000lb (13.3kN) thrust jet.



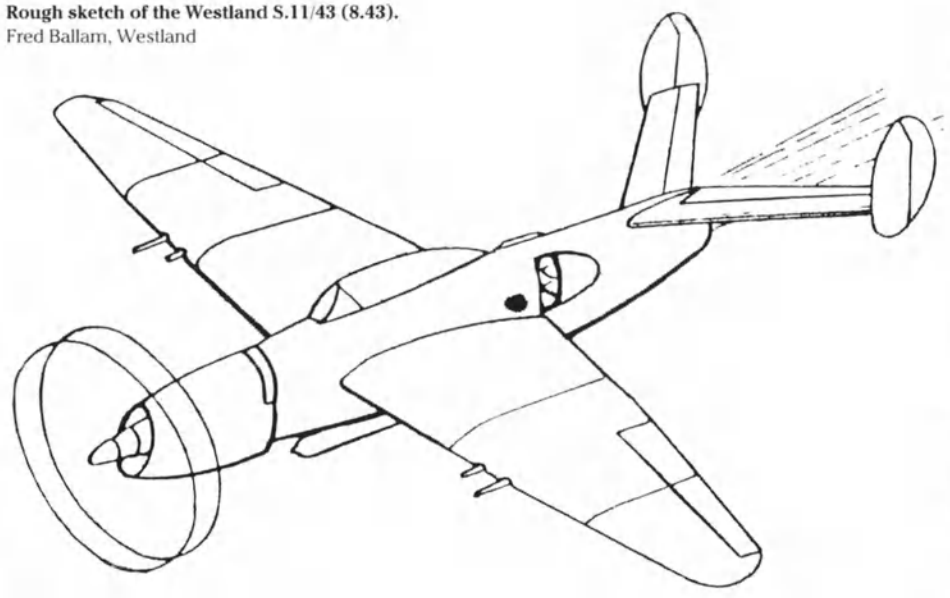
Fairey S.11/43 combined powerplant design (24.5.43). The variant to O.5/43 (2.7.43) was near identical.

Westland S.11/43

Westland's S.6/43 was modified into a propeller-cum-jet machine with a Pratt and Whitney R-4360 radial in the nose and a Halford H.1 jet further back, the jet being used for take-off and boosting the top speed. The wings were not dissimilar to the S.6/43 but the unusual butterfly tail was highly swept with twin rudders at the tips. Two cannon were mounted in each wing's leading edge and, surprisingly, a torpedo could be carried externally beneath the cockpit.

Shorts S.38 and Sturgeon

The above designs were eventually rejected and an ITP was given to Shorts in October 1943 for its twin-Merlin project, now numbered S.38, which was eventually called the S.A.1 Sturgeon. Details of the original proposals have not been traced but S.11/43 was rewritten around them and reissued to the company on 12th February 1944 to cover three S Mk.1 prototypes, RK787, RK791 and RK794 ordered on 19th October 1943. Provision for the subsequent installation of Griffons was also requested. Designed by the team led by C P T Lipscombe, RK787 made its maiden flight on 7th June 1946 and the type was the first twin-engined aircraft specifically designed for FAA service, although by the time RK787 flew two de Havilland creations,



Rough sketch of the Westland S.11/43 (8.43).
Fred Ballam, Westland

Short Sturgeon prototype RK787. Short Bros.

the Mosquito and Hornet, had found their way on to the deck of an aircraft carrier.

Both Hornet and Mosquito highlighted a major problem of twin-engine aircraft landing on aircraft carriers, the lack of asymmetric control with one engine out that was required during the high-power/low-speed approach. Due to this the conventional Mosquito could not be deck-landed on one engine and, in addition, its propellers rotated in the same direction which gave the added problem of swing on take-off. The naval Sea Hornet received handed engines and propellers which removed the swing problem, but the asymmetric difficulty remained. It was hoped that the Sturgeon might prove better suited for single-engine landings since the shorter blades of its contra-rotating propellers allowed the engines to be placed closer to the fuselage centreline, thus easing the asymmetry weakness. In the event however, single-engine deck landings still proved to be impractical.

The Sturgeon was essentially designed for operations in the Pacific as part of preparations for the final drive against Japan, but after that conflict ended the navy was left with a new bomber and nowhere to use it. The type was intended to operate from *Ark Royal* and *Hermes* class carriers but post-war economies were to cancel or suspend the construction of these ships (none was to commission before 1952) with the result that the only possible home for the Sturgeon could be the wartime *Illustrious* class or the *Colossus* type Light Fleet Carrier. Operation on the former would require a stronger arrester gear while the Sturgeon itself would have to remain above deck at all times. As a result the reconnaissance-bomber Sturgeon did not enter production, but before the end of the war it was adopted as a humble target-tug. Conversion to the TT Mk.2 variant, which Shorts originally called the S.39 and then S.A.2, was undertaken to Specification Q.1/46 and the third S.A.1 prototype, RK794, was modified to act as the prototype. Reserialled VR363 it made its maiden flight on 18th May 1948 and 24 production aeroplanes were built.

Specification O.5/43 and O.21/44 Fairey Spearfish

After the decision to abandon the S.6/43 torpedo bomber/reconnaissance aircraft, staff requirements for a torpedo/dive bomber were considered at a Design Committee meeting held on 12th April 1943. It was agreed that the tactics of torpedo and dive bombing had much in common and it was far easier to combine these two tasks rather than the torpedo role with reconnaissance. The original requirement for a dive bomber had centred around the carriage of a 1,600lb (726kg) bomb and, although replacing it with a torpedo was not expected to be detrimental to the dive bomber's performance, it was decided to wait for the arrival of the dive bomber design studies and then, picking the best, to consider carrying a torpedo. Much discussion centred around whether the type should be a single or two-seater. The specification was numbered O.5/43 and brought the following proposals.

Cunliffe-Owen O.5/43

A single-engined design for which no data has been found.

Blackburn B.47

A single-engined two-seat design with a rear defensive turret.

Fairey O.5/43 single-engine

Since the O.5/43 was envisaged to be a heavy aeroplane, one of the available 'large' engines would be needed which Fairey placed in the order Griffon 61, Centaurus or Sabre. It was proposed to limit the diving speed near to the maximum level speed and, following conversations with Rotol and de Havilland, Fairey had formed the opinion that deceleration by airscrew drag had reached a stage of development where it could be a practical possibility in about a year's time. Retarding the aircraft by airscrew drag was so attractive, with no effect on the aircraft, that the designers suggested that reliance should be placed on it as a first string with development of the reversing airscrew accelerated. Although experimental, much progress had already been made on this concept.

Full-span flaps were fitted which offered the chance to increase the wing loading by 15% but a tricycle undercarriage was rejected. Stressed skin construction was used throughout and the Griffon 61 power egg had annular type air intakes as developed for the Halifax bomber. Except for two 250lb (113kg) bombs or some rockets under the outer wings, the bomb load was carried beneath the fuselage. A defensive turret had been ruled out because of its weight and drag but a single 0.5in (12.7mm) was available. With Griffon 61, Sabre III and Centaurus 7.SM respectively, time to 10,000ft (3,048m) was 8.67, 7.5 and 7.0 minutes, service ceiling 28,500ft (8,687m), 26,000ft (7,925m) and 25,300ft (7,711m), and each could achieve the 900nm (1,667km) range, or 1,500nm (2,778km) with extra fuel. In fact, to save weight, half of the specified endurance fuel had been termed 'overload' which reduced the stressing required and had produced a smaller aircraft – 'Scheme A'. An alternative 'Scheme B' carried all of the specified fuel but it was larger with a span of 56ft (17.1m) and length 45ft (13.7m) and was not examined closely.

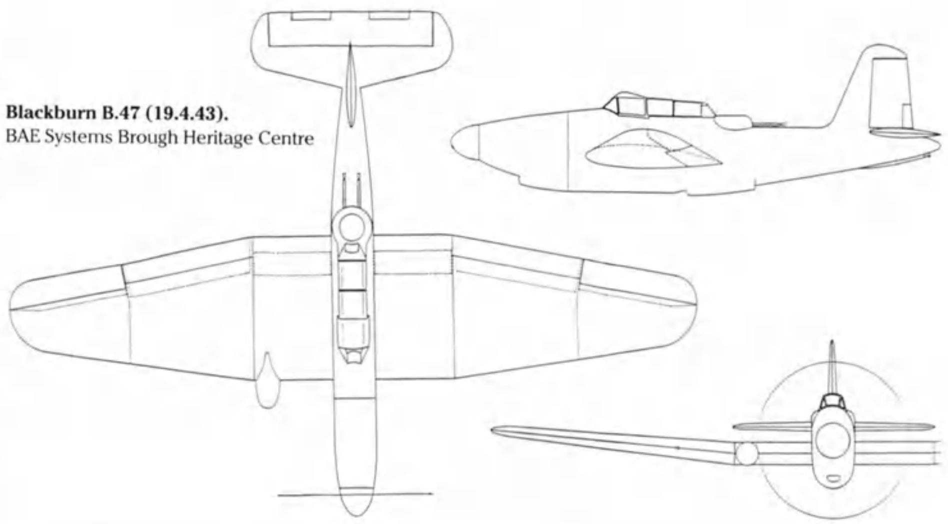
Fairey O.5/43 twin-engine

Fairey declared that the advantages of this alternative included a perfect view for the pilot at all times, the ability to get home on one engine and a greatly improved performance over the single-engine type. It was principally built of stressed skin construction and all of the bomb load was totally enclosed in a fuselage bay. For rear defence the second crewman had a hydraulically-operated 'Rose' type gun pillar with one 0.5in (12.7mm) Browning gun while, to combat a forward attack, two forward-firing fixed 0.5in were mounted in the nose of the bomb compartment. An alternative cannon armament of four 20mm or one 37mm could be carried instead of the bombs, or an auxiliary fuel tank could be housed in the bomb compartment to give the 1,500nm range. Full-span flaps were used and the wing fold rotated about two axes. Time to 10,000ft (3,048m) was 7.1 minutes and service ceiling 31,200ft (9,510m). Fairey stressed its preference for this design over the single-engine on the score of performance and view.

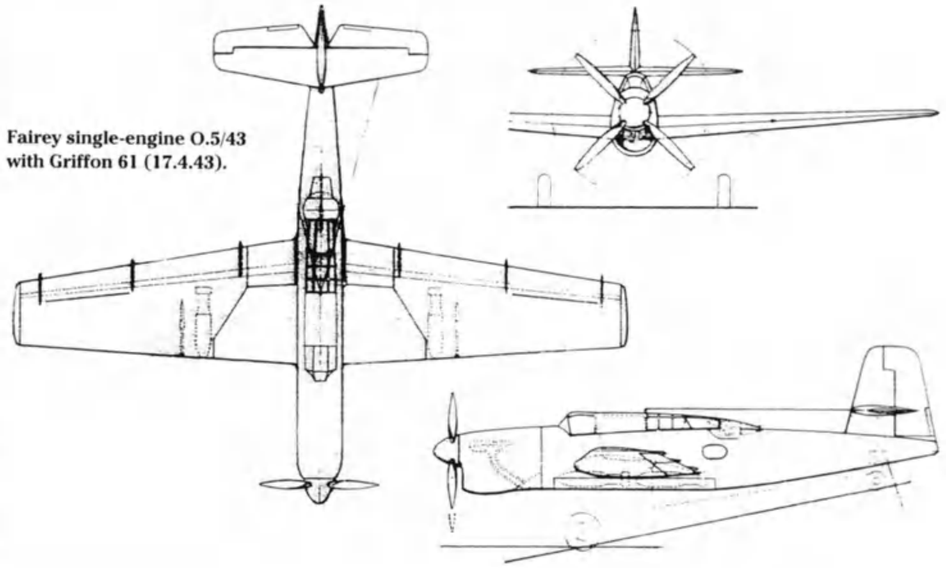
Folland Fo.119

This single-engine design 'arrived late', but no details survive.

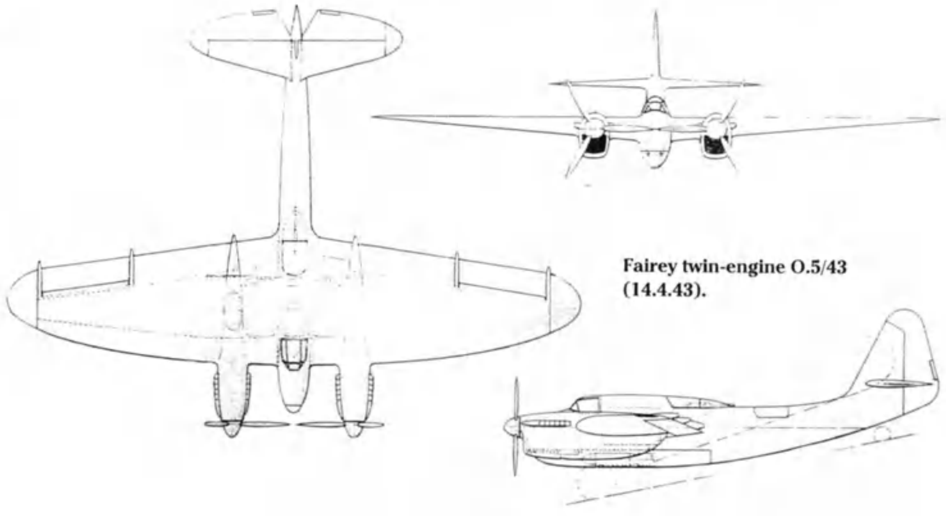
After close analysis MAP concluded that the two Fairey projects, adapted to carry a torpedo, were worthy of serious consideration.



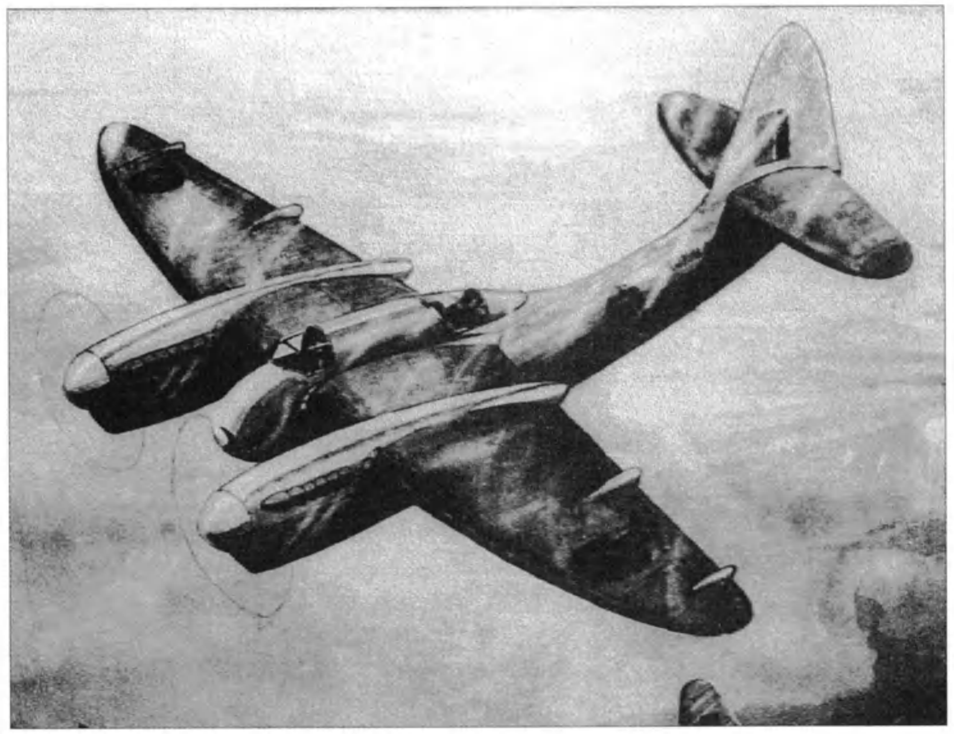
Blackburn B.47 (19.4.43).
BAE Systems Brough Heritage Centre



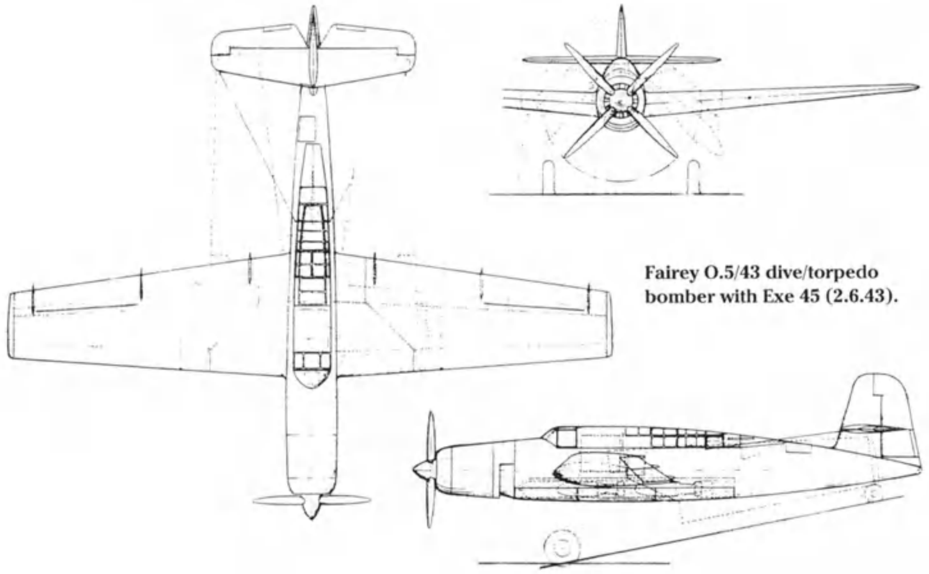
Fairey single-engine O.5/43 with Griffon 61 (17.4.43).



Fairey twin-engine O.5/43 (14.4.43).



Artist's impression of the rather ugly Fairey twin-Merlin O.5/43 project.



Fairey O.5/43 dive/torpedo bomber with Exe 45 (2.6.43).

Both depended on some experimental features in the form of full-span flaps which were to be power operated to give lateral control. Spoiler lateral control was to be brought into play under conditions when, due to the limited movement of the full-span flaps in the retracted position, lateral control by power operation of the flaps alone would not be wholly satisfactory. Similar expedients were under development in America by the Vought company and such features were desirable if the best was to be obtained from this type of aeroplane.

The real issue, however, was the relative merits of the two projects. With a 2,200lb (998kg) torpedo, it seemed that the twin-Merlin could be built at around a 26,000lb (11,794kg) weight with a top speed of about 350mph (563km/h) at 19,000ft (5,791m). Apart from the obvious objections in regard to numbers that could be stowed aboard carriers, it was clear that the margin between 26,000lb and the Admiralty's absolute limit of 30,000lb (13,608kg) was too small for an ultimate development using more powerful engines such as the Griffon. The single-engined design with Griffon, Centaurus or Sabre would work out at about 19,000lb+ (8,618kg), making it underpowered with any of these units. However, the adoption of the Centaurus appeared to permit the possibility of fitting the more powerful Rolls-Royce Exe 45 (a 45 litre air-cooled inline development of the original smaller Exe designed for the Barracuda) or the new American Pratt & Whitney 4360 later on. The new Exe appeared to have the potential for 3,000bhp (2,237kW) but began with a take-off power and dry weight comparable to the Centaurus. The 4360 also promised 3,000bhp but it was a larger and heavier engine.

It was thought that when carrying a 1,800lb (816kg) 18in (7.1cm) torpedo, the single-engined Fairey might start at 20,000lb (9,072kg) all-up-weight and give a maximum 310mph (499km/h) at 19,000ft, but there was potential for another 30mph (48km/h) later. Therefore, apart from its greater ease of stowage in carriers, the type had a better potential improvement than the twin-Merlin whilst keeping well within the Admiralty's maximum weight limit. It was agreed that a closer examination of the single-engine Fairey should be pursued and a further design study followed based on the lines of the original.

Fairey O.5/43 Developments

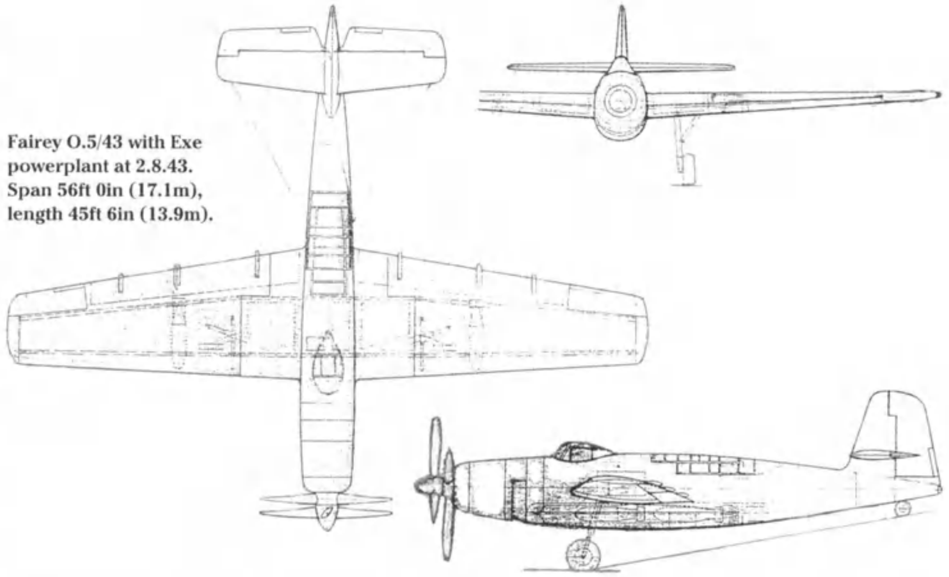
At the request of CNR Fairey remodelled its O.5/43 single-engine layout by improving the power loading and extending the bomb bay to carry an 18in (45.7cm) torpedo, stowed internally. This was completed on 7th June 1943 and the company felt that this type was now a logical follow-on from the Barracuda; the proposed engine was an Exe 45. The net result was an increase in the total weight of the aircraft by 1,070lb (485kg) with a consequent increase in size which, with the Exe 45's provisional rating, actually gave a reduction in performance compared to the original submission's Centaurus. This change had been made to accommodate the Exe 45 with its possible development to 3,000bhp (2,237kW) but Fairey suggested that, since the Centaurus was an available engine, a prototype should be built around this unit but with an eye to future adoption of the Exe 45 or one of the big American engines. To accommodate the torpedo it had been necessary to introduce a cranked centre section spar. The Centaurus would take the aircraft to 10,000ft (3,048m) in 6.45 minutes, the service ceiling was 24,000ft (7,315m) and this engine reduced the length of the fuselage by 2ft (61cm).

On 3rd July Fairey followed this up with a brochure designed around a combination powerplant using a Merlin 26 piston and a 3,000lb (13.3kN) thrust jet. This investigation, which also embraced very similar work to S.11/43, was primarily intended to find if the co-axial arrangement of engines had any advantage over the large single engine. Fairey found that this design provided all of the advantages of a twin without any of the drawbacks associated with deck flying. The use of a relatively small piston engine for cruising, with a consequent small diameter propeller, reduced the length required for the bomb projector arms which meant that the whole arrangement could be mounted on a short tricycle undercarriage. The design had a ceiling of 36,000ft (10,973m), would take five minutes to get to 10,000ft (3,048m) and with the jet switched off had a top speed of 261mph (420km/h) at 9,500ft (2,896m).

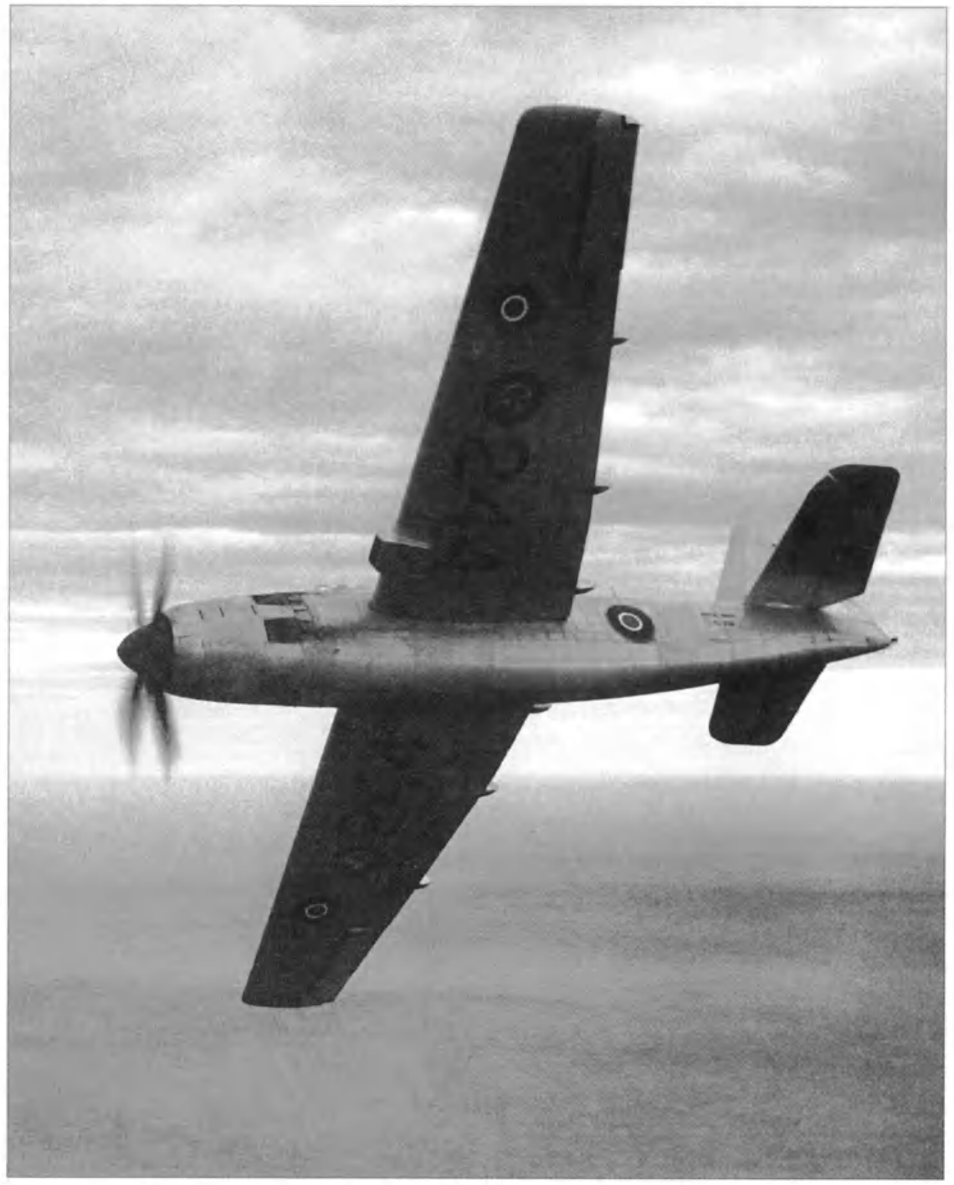
However, a prototype order for the piston only type was placed in mid-August and on the 23rd Fairey confirmed that a Centaurus 7 or 12.SM would be fitted in the first instance with the Exe 45 later. A drawing was enclosed showing how the aircraft would look with the Exe (including a contra-rotating propeller) but it differed quite markedly from what was eventually built; at 23,700lb (10,750kg) weight the top speed would be 360mph (579km/h) at 15,000ft (4,572m). This big aircraft was eventually named Spearfish and the first of four prototypes to fly became airborne on 5th July 1945. A fifth prototype never flew and two more, plus 150 production examples, were to be cancelled. On 18th April 1945 a Spearfish conversion was proposed to act as a test bed for the Rolls-Royce Clyde turboprop, which gave 1,850bhp (1,380kW) and 750lb (3.3kN) thrust; at 18,374lb (8,334kg) weight this was expected to give 335mph (539km/h) at 15,000ft (4,572m).

Fairey O.21/44

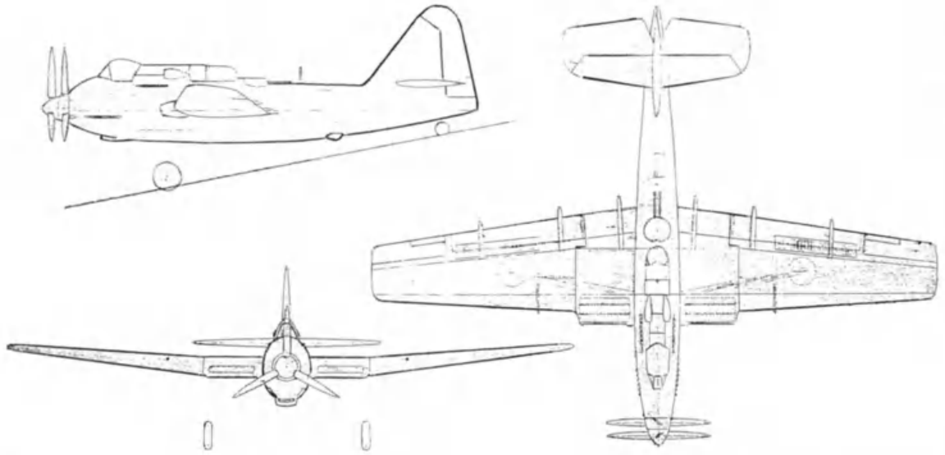
Although a considerable demand was expected for the O.5/43 Spearfish the type had hardly got into its stride when the Naval Air Staff felt the need for a strike aircraft of higher performance. To meet this line of thought, in September 1944 Fairey put for-



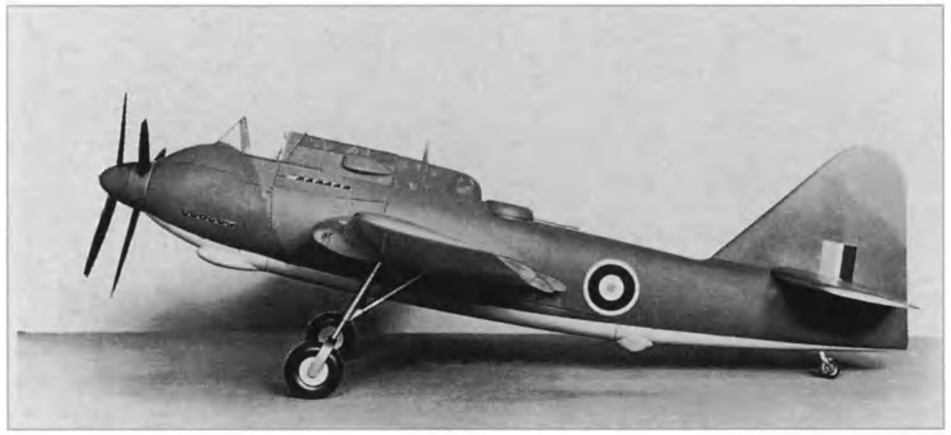
Fairey O.5/43 with Exe powerplant at 2.8.43. Span 56ft 0in (17.1m), length 45ft 6in (13.9m).



This was one of the first airborne photographs of the Fairey Spearfish to be released. The number '244' does not relate to a serial, but rather shows that the Spearfish was number 244 in a series of experimental general arrangement drawings.
FlyPast



Fairey O.21/44 (21.7.44). The aircraft had a single 0.5in (12.7mm) machine gun in each wing and two more in a defensive turret.



Model of the Fairey O.21/44 (photo issued 25.10.44).

ward a brochure that modified the O.5/43 with a twin coupled-Merlin arrangement which used the same airframe components and showed on estimate a considerable improvement in performance. Fairey felt that the O.5/43's value could be greatly improved if its speed could be increased from the present 300mph (483km/h) to at least 350mph (563km/h) and a small separate design team had been working on this problem for several months. As a result the use of large engines like the American 4360 was now rejected because the length became inconvenient while the pilot's view suffered.

During these investigations, which included contact with Rolls-Royce to discuss an extension shaft drive with a single engine which enabled the pilot to sit forward of the engine to obtain the best possible view, Fairey had conceived the idea of utilising two Merlins arranged in tandem within the fuselage. The forward engine incorporated and drove a special nose gearbox with a single pair of contra-rotating propellers, to which the rear engine was coupled by means of an extension shaft. The front engine drove the rear propeller and the rear engine the front propeller, the two drives being quite independent of each other so that the machine might be flown with one engine and one propeller only. By this route Fairey could see a way of installing 4,000bhp (2,983kW) in the aircraft with a minimum increase in drag and weight. Besides having twin-engine reliability without the danger of asymmetry with one engine out, and a high performance due to the low frontal area, this arrangement appeared more desirable than the piston plus jet because only one type of fuel was necessary while the thrust efficiency was much higher, giving a better take-off and landing performance. The jet's high fuel consumption was also taken out of the equation.

To investigate the twin piston in tandem system a long and comprehensive series of design studies was prepared, all of them around the O.5/43 specification except that the machine was considered as a single seater with no rear defence. The alternatives studied were a normally situated single tractor Rolls-Royce Pennine or Eagle, a conventionally arranged twin Merlin 14.SM, a tandem twin single-stage Griffon 23.SM or one Pennine plus a 3,000lb (13.3kN) Halford jet. The investigations showed that the tandem engine arrangements gave a performance which, at the time, was superior to any other powerplant and it was decided to submit to CNR and DTD three projects to illustrate the new principle and its advantages:

1. A normal two-seat aircraft to O.5/43 in standard production form, except for a new fuselage forward of the front wing spar which incorporated twin tandem Merlin 14.SMs (initial project dated 21st July 1944; this became the core of the September brochure).
2. A single-seat torpedo/dive bomber to the O.5/43 specification but without rear defence. It had twin 2,400bhp (1,790kW) Griffon 71s in tandem which gave an all-up-weight of 24,800lb (11,249kg), 420mph (676km/h) top speed and a maximum rate of climb of 1,770ft/min (539m/min) (13th September 1944).
3. A single-seat conversion of the O.5/43 with one 2,520bhp (1,879kW) Rolls-Royce Pennine RX.2.SM piston and one 2,000lb (8.9kN) jet in tandem, which weighed 21,900lb (9,934kg) and gave a speed of 370mph (595km/h) (13th September 1944).

In due course a contract was placed for four twin-Merlin two-seaters to the general requirements of O.5/43, the actual specification for these machines, O.21/44, being written around the new design. The project would have an internal fuel capacity of 470gal (2,137lit) and a range of 900nm (1,669km). Fairey was very enthusiastic about the idea and design work commenced at the beginning of 1945 in the hands of a special team at Fairey's Stockport works – it was intended that the detail design and construction of these four machines should be carried out at Stockport. During August 1944, whilst the three projects submitted to MAP were being discussed, Fairey was requested to investigate the possibilities of the tandem twin-engine scheme in a new project, a naval strike aircraft. The resulting Fairey Strike Fighter was submitted in October and is described in Chapter 10, which continues the long saga of Fairey's wartime research into naval strike aircraft.

However, developments in jet and propeller turbines were beginning to reveal their value and the general feeling was that all reciprocating types would rapidly become obsolete. Therefore, after a few months of effort in the Fairey drawing office, the O.21/44 contract was cancelled; this same reasoning also brought the demise of the O.5/43 contract.

Bristol Brigand

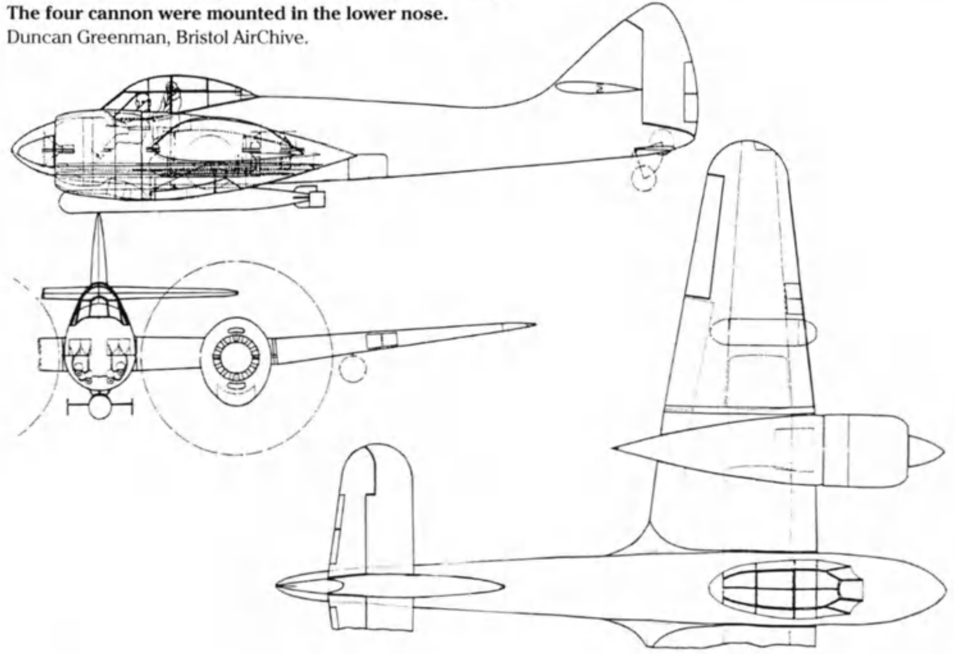
On 18th May 1942 Air Marshal Sir Philip Joubert of HQ Coastal Command informed Air Marshal F J Linnell, CRD, that the stage had been reached where, because its losses had become so severe, the American Lockheed Hudson was 'virtually useless' as an anti-shipping aircraft. Consequently experiments were under way to put torpedoes, bombs and rocket projectiles onto the Beaufighter. The Beaufighter eventually succeeded the Beaufort in the torpedo bomber role and proved such a success that suggestions for a more advanced aircraft gained momentum. The Beaufighter was essentially the first of a new class of 'strike' aircraft.

On 8th July 1942, at Bristol's wartime design headquarters and project office at Ivor House, some rough ideas for a future requirement were laid down by Sorley, Rowe and Boothman of the Ministry, Frise, Russell and Morgan from Bristol and the company's RTO, H J Webb. Bristol offered two alternatives:

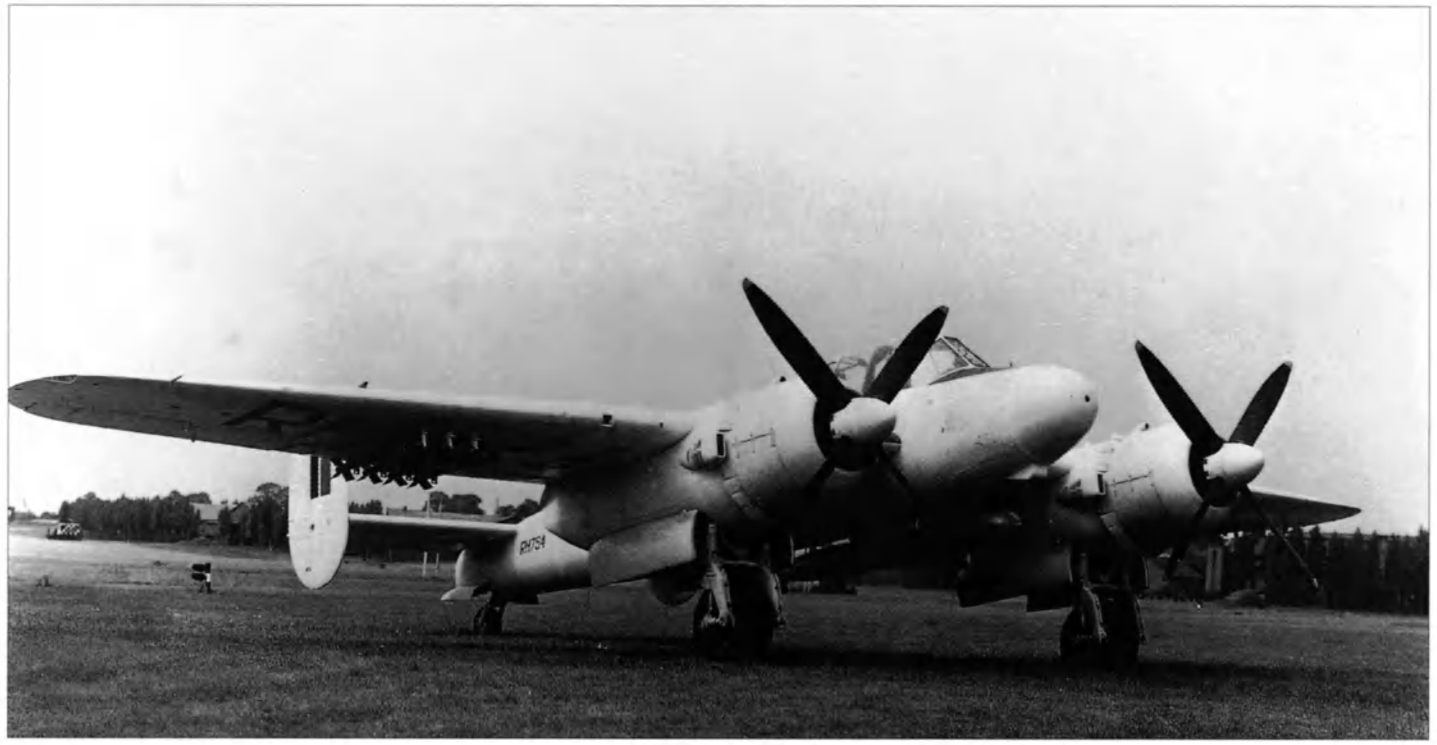
i. an aircraft derived from the Beaufighter with one torpedo and four 20mm cannon, 24,900lb (11,295kg) take-off weight, 503ft^2 (46.8m^2) wing area and a maximum 327mph (526km/h) at sea level, or
ii. a Buckingham II derivative of 32,500lb (14,742kg) with two torpedoes, a 708ft^2 (65.8m^2) wing and capable of 340mph (547km/h) at sea level.

A redesigned Beaufighter with a new body was eventually selected, drawings were issued for a fuselage mock-up and on 26th August Specification S.7/42 was raised to cover the project (this was renumbered H.7/42 on 15th September). Bristol suggested that the new aircraft might be called Buccaneer and hoped for a possible first flight in November 1943. The Beaufighter's navigator was moved to a position just behind the pilot which made the task of torpedo direction somewhat simpler.

As the work proceeded the design reached a stage where it no longer had much in common with the Beaufighter. The estimated all-



Bristol H.7/42, tentatively named Buccaneer, as at 3.11.42. The four cannon were mounted in the lower nose.
Duncan Greenman, Bristol AirChive.



Bristol Brigand TF Mk.1 RH754, in Coastal Command colours, is seen fully armed with a single torpedo and eight rockets, c1946.
David Charlton, BAe Filton

up-weight rose to 27,000lb (12,247kg) and so the span had to be increased to keep down the wing loading, which meant that the new fuselage and tail unit now had a completely redesigned wing to go with them and even the strengthened Beaufighter undercarriage would need further alteration should the weight go any higher. All of this reduced the top speed and left only a very small margin for development, a bad policy for a type not due to enter production for two years. Attempts were made to cut the drag, the most obvious way on the Beaufighter being the engine nacelles.

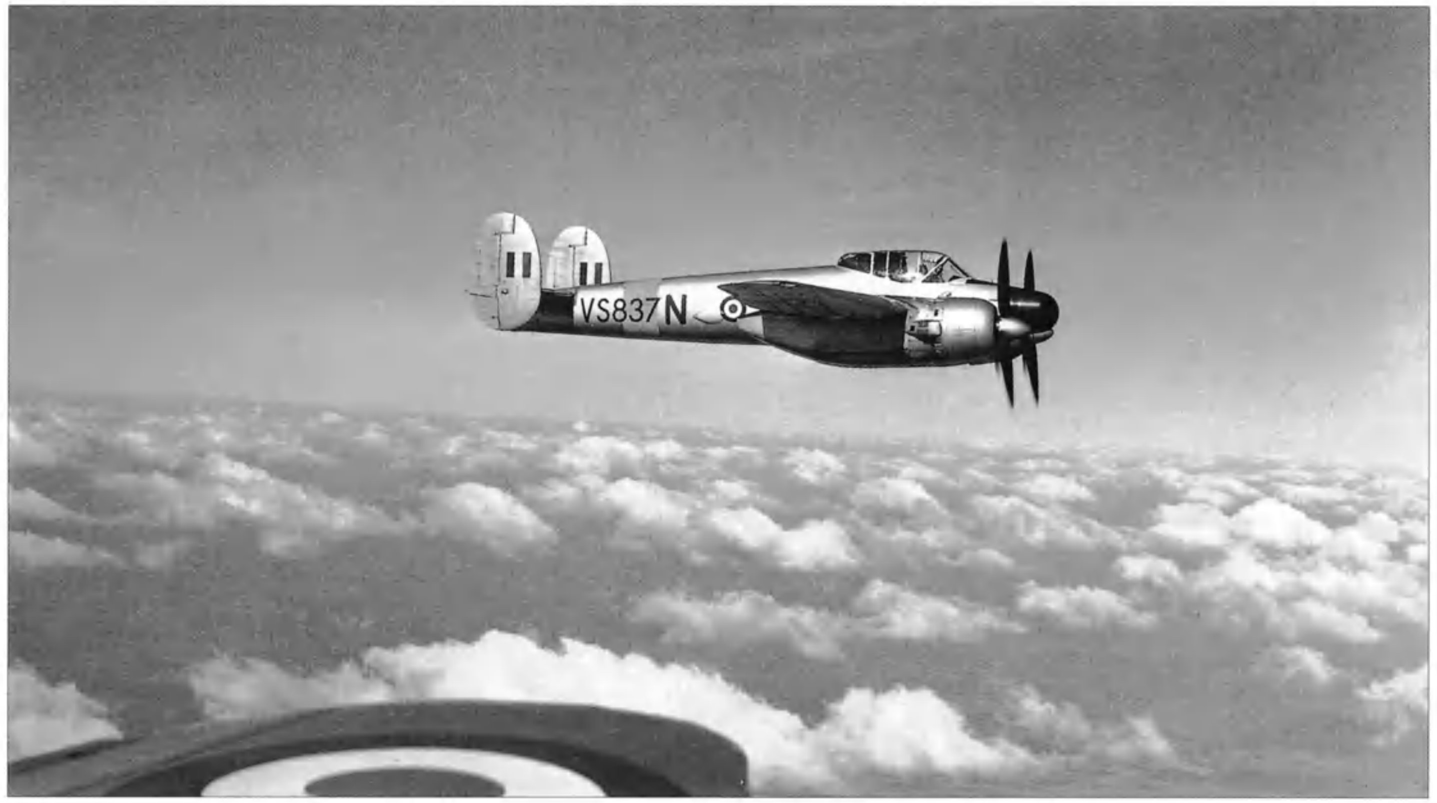
Frise and Russell were so concerned that they suggested fitting Centaurus engines instead of the Hercules or, in other words, combine the Buckingham wings and power units with the present H.7/42 fuselage of smaller cross-sectional area; the predicted all-up-weights for this machine with either Centaurus and Hercules were 34,086lb and 26,136lb (15,461kg and 11,855kg) respectively. This change was practicable since the spar centres were the same for the two types and Bristol considered that such an adaptation would not only produce a better aeroplane but save time both in design and flight testing. Brake flaps would need to be added to the Buckingham's wings, but this would entail far less design work than the current H.7/42 wing, and the Buckingham tail unit could also be adapted although, at this point, Bristol favoured a single fin and rudder.

The result would be a fast aircraft with a crew of three and a fuselage layout identical to that already mocked-up and agreed for the H.7/42, and this was accepted on 11th March 1943 as the Type 164. The Beaufighter-based project had become overloaded and its performance had forced this switch to a new aircraft, a decision that put much less strain on the Bristol design organisation. Specification H.7/42 had been issued 10th December 1942 and called for a high-speed torpedo attack aircraft and dive bomber with a maximum speed at sea level of not less than 345mph (556km/h). In early February 1943 the new aeroplane was officially called the Brigand TF Mk.1 and the go-ahead to proceed was given in April. Four Brigand prototypes were ordered on 12th April, all powered by the Centaurus VII, and the first, MX988, made its maiden flight on 4th December 1944. On 14th August 1945 MX994 reached 390mph (628km/h) at 13,000ft (3,962m) in a dive.

With the end of Beaufort production, there would no longer be an aircraft available for the training requirements of the Beaufighter and Brigand OTUs so, in May, N E Rowe, DTD, made a dual-control version an urgent requirement. Consequently the Type 165 Brigand II was prepared but then, to simplify matters and not complicate the torpedo bomber's development, in August Bristol proposed a dual-control Buckingham which became the Type 166 Buckmaster to Specification T.13/43, the first example flying on 27th October 1944. Since many components, such as the undercarriage, were the same for all three types – Buckingham, Brigand and Buckmaster – it was planned to attach a flight of Buckmasters to each Brigand squadron for conversion training.

The aircraft was too late to see action in the Far East against Japan and most TF Mk.1s were quickly returned to Filton for conversion into B Mk.1 light bombers with the rear gun removed. In fact during this period the need for an RAF anti-shipping aircraft was abandoned. At the end of the war the RAF had a wide-ranging anti-shipping role but this was rapidly cut down and by 1947 only one Mosquito strike wing remained, which was to be re-equipped with the Brigand. However, instead of waiting any longer, the RAF got out of the maritime strike business altogether and disbanded its last strike wing before the Brigand was ready. In September 1947 it was decided that the Brigand should operate only as a general purpose bomber and it was finally cleared for Service use on 6th March 1948. A total of 147 were built and many served in the Far East before the type was retired in 1958.

Brigand Mk.1 VS837 was converted to a T Mk.4 trainer.

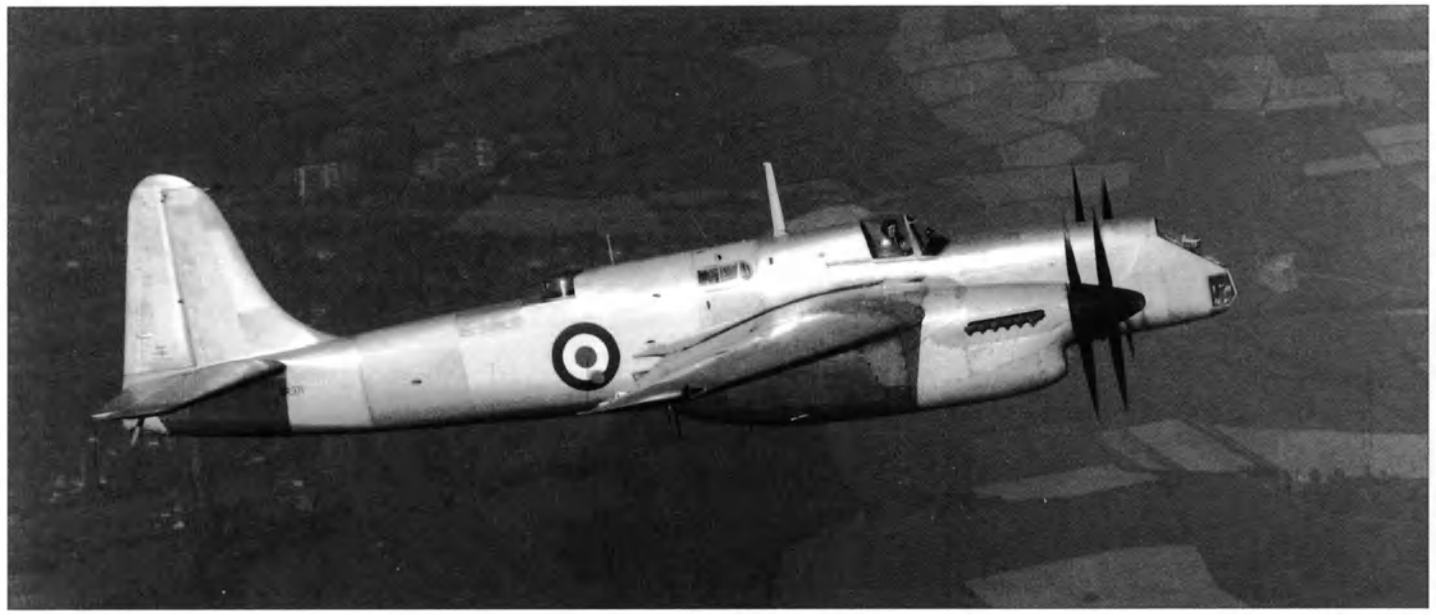


Torpedo Bombers – Estimated Data

Project	*Span* *ft in (m)*	*Length* *ft in (m)*	*Gross Wing Area* *ft² (m²)*	*Max Weight* *lb (kg)*	*Engine* *hp (kW)*	*Max Speed / Height* *mph (km/h) / ft (m)*	*Armament*
Fairey Albacore (flown)	50 0 (15.2)	39 10 (12.1)	?	10,460 (4,745)	1 x Taurus 1,065 (794)	161 (259) at 4,500 (1,372)	4 x 500lb (227kg), 6 x 250lb (113kg) bombs or 1 x 18in (45.7cm) torpedo, 3 x 0.303in (7.7mm) mgs
Specification S.24/37							
Blackburn B.29	c50 0 (15.2)	c40 0 (12.2)	?	?	1 x Exe	?	3 x 500lb (227kg), 6 x 250lb bombs or 1 x torpedo, 1 x mg
Bristol S.24/37	50 0 (15.2)	40 0 (12.2)	450 (41.9)	?	1 x Taurus TE.1.M 1,035 (772)	229 (368) at 5,000 (1,524)	3 x 500lb (227kg), 6 x 250lb bombs or 1 x torpedo, 1 x mg
Hawker S.24/37	50 0 (15.2)	38 6 (11.7)	?	?	1 x Taurus	?	3 x 500lb (227kg), 6 x 250lb bombs or 1 x torpedo, 1 x mg
Supermarine 322	50 0 (15.2)	40 0 (12.2)	?	10,070 (4,568) as bomb/TT carrier	1 x Exe 1,100 (820) or 1 x Taurus TE.3.SM 1,250 (932)	255 (410) or 264 (425) at 5,000 (1,524) recce role	3 x 500lb (227kg), 6 x 250lb (113kg) bombs or 1 x torpedo, 1 x mg
Westland P.10	47 9 (14.6)	?	370 (34.4)	10,500 (4,763)	1 x Taurus	213 (343)	3 x 500lb (227kg), 6 x 250lb bombs or 1 x torpedo, 1 x mg
Fairey Barracuda Mk.I (flown)	49 2 (15.0)	39 9 (12.1)	414 (38.5)	13,177 (5,977) with torpedo	1 x Merlin 30 1,260 (940)	250 (402) clean	3 x 500lb (227kg), 6 x 250lb bombs, 1 x torpedo or 3 x depth charges, 3 x 0.303in mgs
Supermarine 322 'Dumbo' (flown)	50 0 (15.2)	40 0 (12.2)	319.5 (29.7)	12,000 (5,443) design figure	1 x Merlin 30 1,300 (969)	279 (449) at 4,000 (1,219)	3 x 500lb (227kg), 6 x 250lb (113kg) bombs or 1 torpedo, 2 x 0.303in (7.7mm) mg
Beaufort/Botha Specifications							
Boulton Paul P.83	67 0 (20.4)	47 9 (14.6)	575 (53.5)	13,846 (6,281) or 13,739 (6,232)	2 x Pegasus X or Goshawk	254 (409) at 10,000 (3,048)	4 x 500lb (227kg), 250lb bombs or 1 torpedo, 3 x 0.303in mg
Bristol 150	58 0 (17.7)	44 3 (13.5)	492 (45.8)	12,022 (5,453)	2 x Perseus PER.3.M 870 (649)	286 (460) at 5,000 (1,524)	4 x 500lb (227kg), 250lb (113kg) 1 x 2,000lb (907kg) bombs or 1 x torpedo, 3 x 0.303in mgs
Boulton Paul P.84	60 0 (18.3) 67 0 (20.4)	45 6 (13.9) 47 9 (14.6)	495 (46.0) 575 (53.5)	11,430 (5,185) 12,915 (5,858)	2 x Aquila AE.3.M or Goshawk	239 (385) or 245 (394) at 5,000 (1,524)	2 x 500lb (227kg) or 4 x 250lb bombs, 3 x 0.303in mgs
Bristol G.24/35	56 0 (17.1)	39 9 (12.1)	469 (43.6)	10,920 (4,953)	2 x Aquila 670 (500)	254 (409) at 5,000 (1,524)	2 x 500lb (227kg) or 4 x 250lb bombs, 3 x 0.303in mgs
Blackburn Botha Mk.I (flown)	59 0 (18.0)	51 1 (15.6)	518 (48.2)	17,628 (7,996)	2 x Perseus X 880 (656)	253 (407) at 15,000 (4,572)	2 x 500lb (227kg), 4 x 250lb or 1 x 2,000lb (907kg) bombs or 1 x torpedo, 3 x 0.303in mgs
Bristol 152 (Perseus)	58 0 (17.7)	44 3 (13.5)	492 (45.8)	11,725 (5,319) / 12,230 (5,548) torpedo / gen bomber	2 x Perseus 870 (649)	288 (463) at 5,000 (1,524)	2 x 500lb (227kg), 4 x 250lb 1 x 2,000lb (907kg) bombs or 1 x torpedo, 0.303in mgs
Bristol 152 (Aquila)	56 0 (17.1)	44 3 (13.5)	492 (45.8)	10,895 (4,942) / 10,910 (4,949) torpedo / gen bomber	2 x Aquila 670 (500)	262 (422) at 5,000 (1,524)	2 x 500lb (227kg), 4 x 250lb 1 x 2,000lb (907kg) bombs or 1 x torpedo, 0.303in mgs
Bristol 152 Beaufort Mk.I	57 10 (17.6)	44 7 (13.6)	?	21,228 (9,629)	2 x Taurus 1,130 (843)	265 (426) at 6,000 (1,829)	2,000lb (907kg) bombs, mines or 1 x torpedo, 4 x 0.303in mgs
Specifications S.6/43 & S.11/43							
Fairey Torpedo Bomber (8.4.42)	c70 3 (21.4)	c47 8 (14.5)	660 (61.4)	26,090 (11,834)	2 x Merlin 32 1,650 (1,230)	249 (401) at 10,000 (3,048)	3,500lb (1,588kg) torpedoes, 5 x mgs
AWA AW.53	60 0 (18.3)	48 0 (14.6)	?	24,930 (11,308)	2 x Merlin 26 1,600 (1,193)	304 (489) at 9,500 (2,896)	6 x 500lb (227kg) bombs or 1 x torpedo, 8 x RP, 2 x 0.5in (12.7mm) mgs
Fairey S.6/43	c56 8 (17.3)	c45 10 (14.0)	?	25,670 (11,644)	2 x Merlin RM.14.SM 1,960 (1,462)	341 (549) at 17,000 (5,182)	bombs or torpedoes, 2 x 0.5in (12.7mm) mgs or 1 x 20mm cannon
Westland S.6/43	60 0 (18.3)	45 6 (13.9)	550 (51.2)	24,000 (10,886)	1 x Sabre NS.53.SM 2,850 (2,125)	265 (426) at 16,000 (4,877)	1 x 2,000lb (907kg), 2 x 1,000lb (454kg), 5 x 500lb (227kg), 8 x 250lb bombs, 1 x torpedo or 1 x mine, 8 x RP, 2 guns
AWA AW.54	59 0 (18.0)	45 0 (13.7)	500 (46.5)	19,780 (8,972)	2 x Merlin 26 1,600 (1,193)	330 (531) at 9,500 (2,896)	2,000lb (907kg) bombs or depth charges, 2 x 0.5in mgs
AWA AW.54A	53 0 (16.2)	43 6 (13.3)	530 (49.3)	18,840 (8,546)	2 x F.3	450 (724) at 15,000 (4,572)	2,000lb (907kg) bombs or depth charges, 2 x 0.5in mgs
Blackburn S.11/43	c60 6 (18.4)	c43 6 (13.3)	No other details				

Westland S.11/43	55 0 (16.8)	?	470 (43.7)	26,600 (12,066)	1 x R-4360 3,000 (2,237) plus 1 x Halford 3,000 (13.3)	370 (595) at 15,000 (4,572)	bombs?, 1 x torpedo, 4 x 20mm cannon
Short S.38 Sturgeon Mk.I	59 11 (18.3)	44 0 (13.4)	560 (52.1)	21,700 (9,843) norm	2 x Merlin 140 2,080 (1,551)	401 (645) at 18,850 (5,745)	1 x 1,000lb (454kg) or 2 x 500lb (227kg) bombs or 4 x 250lb depth charges in bomb bay, 8 x RP, 2 x 0.5in mgs in nose
Specification O.5/43 & O.21/44							
Blackburn B.47	c52 3 (15.9)	c37 2 (11.3)	No other details				
Fairey O.5/43 (17.4.43)	52 0 (15.8)	42 3 (12.9)	415 (38.6)	17,250 (7,825) 17,285 (7,840) 17,760 (8,056)	1 x Griffon 61 2,100 (1,566) Sabre III 2,310 (1,723) or Centaurus 7.SM 2 425 (1,808)	321 (516) at 18,000 (5,486) 304 (489) at 16,000 (4,877) or 305 (491) at 13,250 (4,039)	6 x 250lb (113kg) bombs or larger or 1 x torpedo, RPs, 1 x 0.5in (12.7mm) mg
Fairey O.5/43 twin-engine (17.4.43)	56 0 (17.1)	43 0 (13.1)	?	24,125 (10,943)	2 x Merlin RM.14.SM 1,680 (1,253)	356 (573) at 17,000 (5,182)	1 x 1,600lb (726kg) or 1,000lb (454kg), 3 x 500lb (227kg) or 250lb (113kg) bombs, or 3 depth charges, 3 x 0.5in mgs
Fairey O.5/43 (7.6.43)	54 0 (16.5)	45 0 (13.7)	?	18,830 (8,541)	Prototype 1 Centaurus 2,500 (1,864) 1 x Exe 3,000 (2,237) later	300 (483) (Cent) at 13,000 (3,962) 352 (567) (3,000hp rating)	4 x bombs or 1 x torpedo in bay, 1 x bomb under each wing, 1 x 0.5in (12.7mm) mg
Fairey O.5/43 mixed powerplant (3.7.43)	56 0 (17.1)	46 0 (14.0)	?	21,850 (9,911)	1 Merlin 26 1,620 (1,208) plus 1 jet 3,000 (13.3)	373 (600) at 20,000 (6,096)	4 bombs or 2 torpedo, 1 gun in each wing, 1 rear facing mg
Fairey Spearfish (flown)	60 3 (18.4)	44 7 (13.6)	?	21,642 (9,817) norm 22,083 (10,017) o'load	1 x Centaurus 2,600bhp (1,939)	292 (470) at 14,000 (4,267)	1 x 2,000lb (907kg) or 1,000lb (454kg) or 4 x 500lb bombs, 1 x torpedo or 4 depth charges, RPs, 4 x 0.5in (12.7mm) mgs
Fairey O.21/44	60 0 (18.3)	45 5 (13.8)	?	23,700 (10,750)	2 x Merlin RM.14.SM 2,200 (1,641) total	360 (579) at 15,000 (4,572)	bombs, torpedoes, 1 x 0.5in (12.7mm) mg in each wing, 2 x 0.5in mg in rear turret
Specification H.7/42							
Bristol H.7/42 'Buccaneer'	c58 2 (17.7)	c45 1 (13.7)	503 (46.8)	24,900 (11,295)	2 x Hercules	327 (526) at S/L	1 x torpedo, 4 x 20mm cannon
Bristol 164 Brigand Mk.I (flown)	72 4 (22.0)	46 5 (14.1)	718 (66.8)	39,296 (17,825)	2 x Centaurus 57 2,500 (1,864)	359 (578) at 16,100 (4,907)	1 x 2,000lb (907kg) or 2 x 1,000lb or 600lb bombs, 1 x torpedo or 1 x 1,000lb mine, 4 x 20mm cannon, 1 x 0.5in mg

Production Short Sturgeons were produced as target-tugs. This picture shows VR371. Short Bros.



Naval Fighters

View of the Blackburn S.28/43 'Firecrest' prototype VF172 taken on 3rd February 1949. BAe Brough Heritage

This chapter covers essentially two categories of aircraft, pure fighters and a type that was termed 'strike fighter'. Some naval fighters were modified versions of RAF types and the development of the Hawker Sea Fury to N.22/43, the Supermarine Seafang to N.5/45 and Supermarine's Type 391 project have already been described in Chapter 1.

Fairey Fulmar

This fighter, based on Fairey's aircraft built to the P.4/34 light day bomber specification (Chapter 4), was ordered to Specification O.8/38 as an interim two-seat front gun FAA fighter. The prototype, N1854, flew on 4th January 1940 and the type entered service in the following June. Although built in comparatively small numbers and suffering from a relatively low speed, it carried a heavy forward armament of eight 0.303in (7.7mm) machine guns and proved quite successful, serving through most of the war.

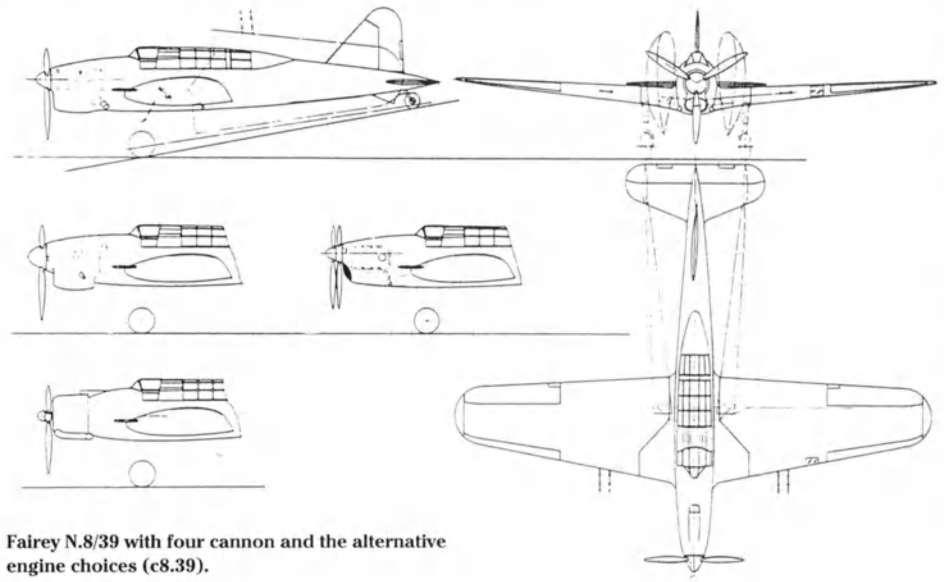
Specification N.8/39 and N.9/39 Blackburn Firebrand and Fairey Firefly

In 1938 work began on two new specifications for the FAA, N.5/38 for a two-seat fighter and N.6/38 for a turret fighter. These were quickly updated to N.8/39 and N.9/39, both dated 21st June 1939. N.8/39 called for a top speed at 15,000ft (4,572m) of at least 275 knots (317mph/510km/h) and an interchangeable armament of eight forward-firing 0.303in (7.7mm) Browning machine guns or four 20mm cannon; N.9/39's requirements were identical apart from four Brownings in a turret. On 10th August the two documents were issued to tender to seven companies and five had replied by 19th September.

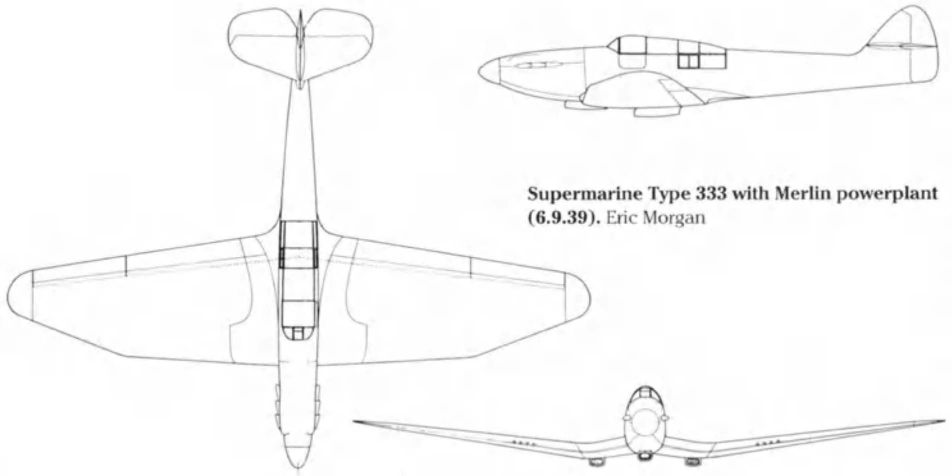
Blackburn N.8/39

Powered by a single Hercules, this project's main and tailplanes used light alloy tube and plate construction with fabric-covered control surfaces while the fuselage used Alclad monocoque. The layout had a symmetrical inboard wing section which was then cambered towards the tips and employed 35% slotted flaps and a fixed undercarriage (which could be jettisoned when alighting on the sea). Fuel capacity was 190gal (864lit)

Fairey Fulmar Mk.II N4062.



Fairey N.8/39 with four cannon and the alternative engine choices (c8.39).



Supermarine Type 333 with Merlin powerplant (6.9.39). Eric Morgan

and service ceiling 33,800ft (10,302m). Blackburn quoted 18 months to complete three aeroplanes with the first prototype to be supplied in twelve months.

Fairey N.8/39

This design was offered with four alternative engines – the Rolls-Royce Boreas (=Exe) or Griffon, the Bristol Taurus or Fairey's own 'Queen' power unit, the respective fuel capacities being 145gal (659lit), 192gal (873lit), 143gal (650lit) and 159gal (723lit). The wing and tail were built of conventional light alloy, except for the wing centre section rear spar which used tubular steel, and had fabric-covered control surfaces. Wingtip slots were fitted, the flaps were hydraulically-operated and the guns were mounted in the wings. Fairey noted that the extremely limited folded width had been achieved by reducing the width of the centre section to an absolute minimum. As a result the length of the folding wing portion was considerable and it had been necessary to place the tailplane at the extreme aftermost limit possible within the required overall dimensions. In addition the fin and rudder had been arranged forward of the tailplane and the resulting arrangement was excellent from an anti-spinning point of view. The rear fuselage was monocoque and both front and rear ends used tubular construction. The Griffon gave a service ceiling of 31,600ft (9,632lit) and the first aircraft would need 18 months for delivery, with the second and third following at two month intervals.

Gloster N.8/39

Here the engine choice was the Hercules HE.6.SM or Napier E.112 with respective fuel capacities of 210gal (955lit) and 200gal (909lit). Again a conventional light alloy stressed skin wing and tail structure was employed with fabric covering on the control surfaces but the fuselage was fabric-covered tubular steel and duralumin. Wingtip slots, Handley Page slotted flaps and a retractable undercarriage were fitted although the main wheels did not completely retract. Hercules service ceiling was 33,000ft (10,058m). The first two machines would take 18 months and the third another three.

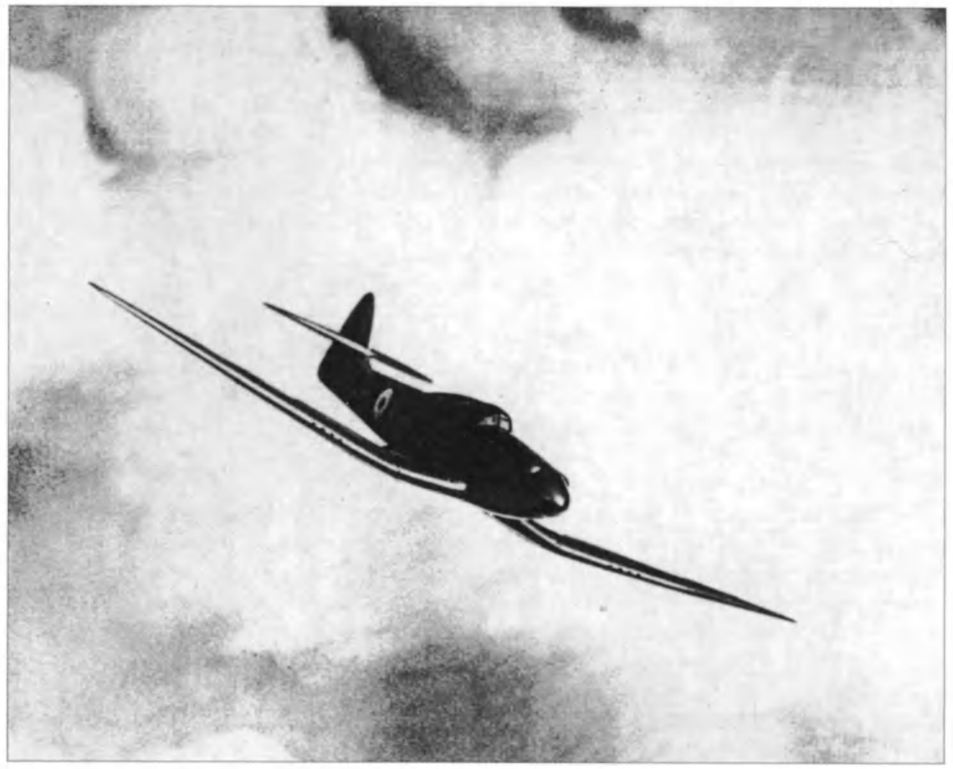
Hawker N.8/39

Sydney Camm offered just the one engine choice, a Napier E.112, but no performance figures were given, although 200gal [909lit] of fuel were carried. The front fuselage used tubular construction, the centre and rear monocoque, and the wing had a D spar as far as the outer guns and then became a two-spar type. Extrusions and Alclad were used on the wing, the tail unit was made in stressed light alloy skin and the ailerons, rudder and elevators were fabric covered. The construction was described as orthodox and followed Hawker practice on the Hurricane and Tornado and the aircraft had wingtip slots, 25% slotted flaps and drooping ailerons. Hawker estimated that about twenty months would be needed to supply the first aeroplane.

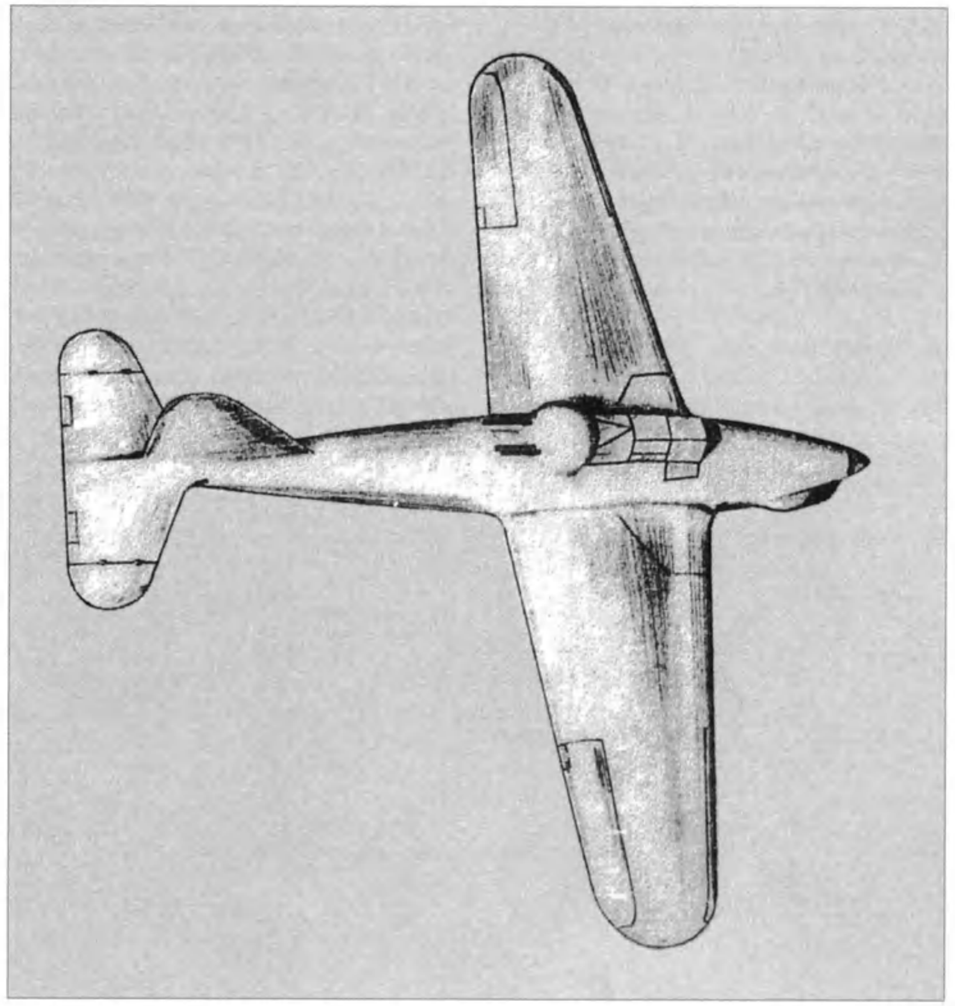
Supermarine 333

Two alternative designs were developed from the Spitfire that were very similar but of different sizes. Both used liquid-cooled engines, the smaller having a Merlin and the larger a Griffon, with twin radiators mounted in the centre section. The important differences came with their performance and their folded width (the larger was 13ft 6in [4.1m] when every other N.8/39 project was 11ft [3.4m]). The monocoque fuselage (a shell structure in light alloy Alclad sheet) and single-spar metal-covered wing followed the practice developed by Supermarine over a number of years while the fuel tanks in the wing nose contributed to the structural strength and stiffness and saved a lot of weight.

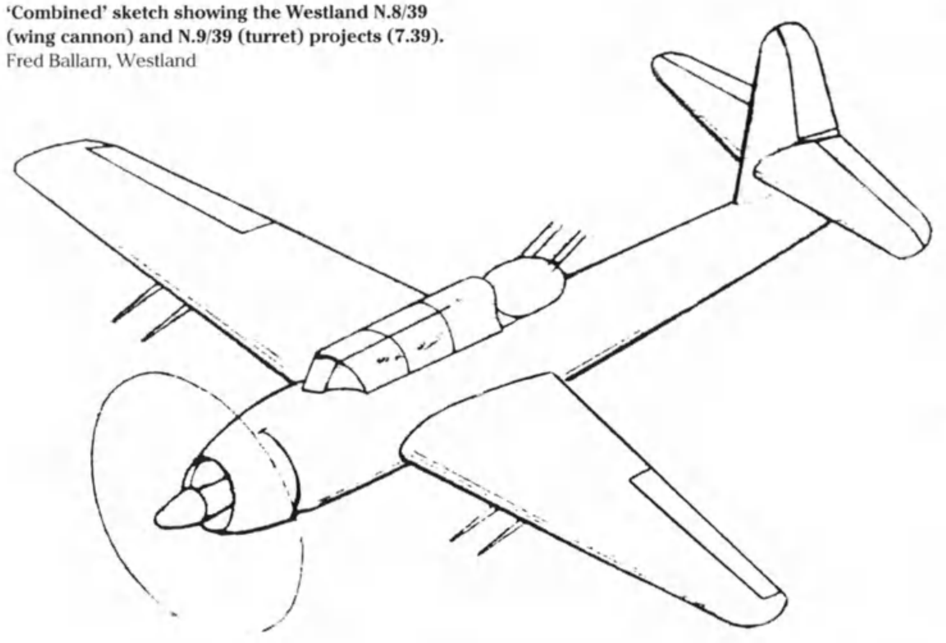
The main difference between the Spitfire wing and the N.8/39 was that the elliptical planform had been discarded in favour of a form incorporating two straight tapers, which approximated very closely to the elliptical form and possessed almost identical aerodynamic properties. The big advantage of the straight taper was that double curvature was avoided and the covering would require no working. No fabric was used except on the control surfaces and slotted flaps were provided over a large percentage of the span; the undercarriage followed Spitfire experience. The four cannon were mounted two per wing just outside the wing fold joint, the eight Brownings (four per wing) were placed outboard of the cannon position. Service ceilings for the two types were 34,700ft (10,577m) (Merlin) and 36,900ft (11,247m) (Griffon), sea level rates of climb 2,650ft/min (808m/min) and 3,150ft/min (960m/min), times to 15,000ft (4,572m) 5.75 and 5.0 minutes and internal fuel 320gal (1,455lit) and 360gal (1,637lit). The first aircraft would take 18 months, the second and third following at six week intervals.



Artist's impression of the Supermarine 333.
Eric Morgan



Artist's impression of the Fairey N.9/39.



'Combined' sketch showing the Westland N.8/39 (wing cannon) and N.9/39 (turret) projects (7.39).
Fred Ballam, Westland

In each case the following N.9/39 projects were, from the aerodynamic and structural points of view, practically identical to their N.8/39 companions but the wing guns had been taken out and a rear four-gun turret added; Supermarine did not tender:

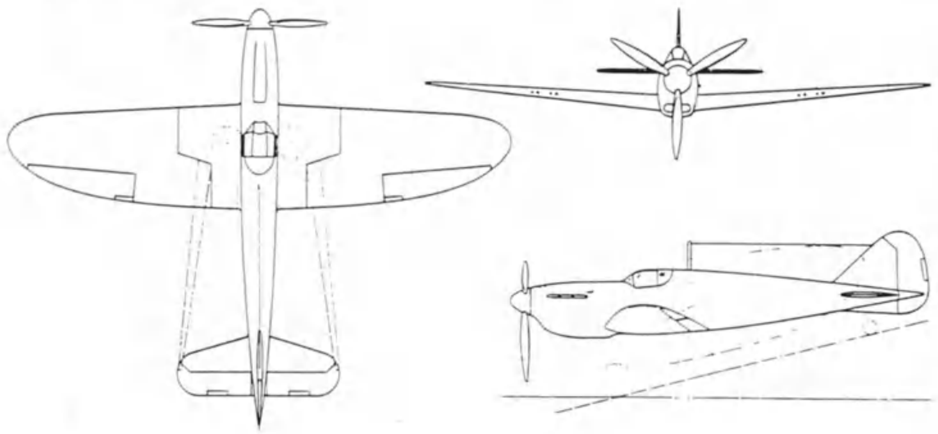
Blackburn B.31

The main difference here came in the centre and rear fuselage. All-up-weight was 9,973lb (4,524kg). It is not known if the B.31 designation covered both projects or if the N.8/39 was called the B.33.

Fairey N.9/39

The only basic difference came at the top of the fuselage in the area of the turret and Fairey stated that a design which, up to a certain stage in manufacture, was common to both types was highly desirable; however, it was stressed that when completed it would not be possible to convert from one type to the other. The Boreas gave an all-up-weight of 9,500lb (4,309kg), top speed 259mph (417km/h) at 15,000ft (4,572m), time to 10,000ft (3,048m) 6.8 minutes and service ceiling 27,000ft (8,230m); for the Griffon the figures were 10,650lb (4,831kg), 303mph (488km/h) at 15,000ft, 4.5 minutes and 31,000ft (9,449m), Taurus 9,260lb (4,200kg), 281mph (452km/h) at 15,500ft (4,724m), 5.83 minutes and 29,000ft (8,839m), and the Queen 9,875lb (4,479kg), 276mph (444km/h) at 15,000ft, 7.5 minutes and 27,500ft (8,382m).

Fairey single-seat fighter to NAD.925/39, fitted with a Griffon and eight machine guns (21.12.39).



Gloster N.9/39

Here the centre fuselage was altered to accommodate the turret, which reduced the length of the Hercules version to 39ft 1in (11.9m). All-up-weights were 9,986lb (4,530kg) (Hercules) and 9,486lb (4,303kg) (E.112). Top speed was 321mph (516km/h) at 17,000ft (5,182). (A drawing is shown in *Gloster Aircraft since 1917*).

Hawker N.9/39

Again only the centre fuselage was affected by fitting a turret; no weights were given.

Westland N.8/39 and N.9.39

In July 1939 Westland began preparing a joint project to N.8/39 and N.9/39 which also included proposals to A.7/39 for an army co-operation aircraft. A 'common' layout for the three specifications used a 1,260bhp (940kW) Taurus and had a span of 50ft (15.2m), wing area 375ft² (34.9m²), all-up-weight (N.9/39) 11,600lb (5,262kg) and top speed (N.8/39) 255mph (410km/h) at 15,000ft (4,572m). On 9th August Westland reported that its investigations were not sufficiently advanced for the specification and asked for an extension of time, but this was refused.

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Aerodynamically all of the N.8/39 designs were straightforward low-wing monoplanes and, except for Blackburn's fixed arrangement, had retractable or part retractable undercarriages. Supermarine's was the cleanest design but a small tail suggested that its longitudinal stability might be inadequate and possibly the directional stability and spinning characteristics as well. The most important structural feature was the wing fold mechanism which produced exceptionally difficult problems. Blackburn had put forward a sound engineering proposition based on the Skua but some of the other companies did not seem to have appreciated the difficulties. Hawker and Fairey were working on reasonable lines but more advanced detailed design was needed, Gloster proposed to adopt Blackburn practice but its adoption to Gloster's own methods of construction may give problems while the Supermarine method gave some concern.

Nevertheless the various Ministry departments placed the Supermarine 333 first, Gloster second (a thoroughly sound design with a good layout), Fairey third (a sound but unimpressive design), Blackburn fourth and Hawker fifth. The order for the N.9/39s was Gloster first (with a rear turret that was aerodynamically very good), Fairey, Blackburn and Hawker. However by 9th December the Admiralty, having postponed the Tender Design Conference twice because it was not ready to discuss the matter, was expected to abandon N.9/39 in favour of a single-seat fixed-gun fighter.

On 23rd December the Admiralty reported that the N.8/39 tenders were unsatisfactory and revealed fresh requirements for single- and two-seat fighters; the turret fighter was now abandoned. The specifications were modified under a document called NAD.925/39 and proposals for alternative single- and two-seat types were requested. The former required a maximum speed of 330 knots (380mph/611km/h) at 15,000ft (4,572m), the two-seat 300 knots (345mph/556km/h). The designs produced to this unofficial document were relatively quick investigations with folding wings and other naval fittings.

Blackburn (B.33?)

The structure of the single-seater was based on Blackburn's N.8/39 and the aircraft had 40% chord full-span flaps, spoiler ailerons and 120gal (546lit) of internal fuel. The dimensions of the two-seater were unchanged from the N.8/39. This design was described by RAE as the best aerodynamically.

Fairey

The new single-seat requirement was of great interest to Fairey, indicating as it did a performance considerably in excess of that hitherto called for in FAA fighters. The greatest attention to clean design had been given to this project and the estimated speed was higher than that obtained in any single-engined fighter presently in service and operating from land aerodromes. This was achieved after taking into account wingfolding, deck catapulting and arresting, a stronger structure than would be needed on land and freedom from corrosion in a salt-laden atmosphere. Two projects were actually submitted, one with a Griffon (the 'primary design') and an alternative with a Sabre, the real difference between the two being one of scale only; their layouts were similar but the Sabre was somewhat larger and offered a higher top speed.

The aircraft had been designed primarily as a single-seat front gun fighter but was adaptable, without changes to the airframe or too much weight penalty, to accommodate an observer and his equipment and canopy; however, he would not have the level of comfort and space provided in the Barracuda torpedo bomber. In view of the high performance required, metal construction was employed throughout for stressed parts and every effort had been made to achieve the maximum possible speed and rate of climb whilst fulfilling the specification. The single-seat Griffon offered a time to 10,000ft (3,048m) of 3.0 minutes, service ceiling 34,000ft (10,363m) and absolute ceiling 35,250ft (10,744m), the Sabre 2.67 minutes, 40,000ft (12,192m) and 41,000ft (12,497m); their respective fuel loads were 123gal (559lit) and 128gal (582lit). The brochure noted that if the Griffon had a 20,000ft (6,096m) supercharger, the speed at this height would be 408mph (656km/h). RAE felt that this was the best design from a structural point of view.

Gloster

Again this design's structure was based on the company's earlier N.8/39. It had slotted flaps and drooping ailerons and could carry 130gal (591lit) of fuel. The two-seater had the same span but its length was 34ft 4in (10.5m) and weight 9,700lb (4,400kg).

Hawker

This project employed a Griffon and used slots and slotted flaps. The structure was based on the Hurricane and Hawker's N.8/39 work and 111gal (505lit) of fuel were carried. Service ceiling was 35,000ft (10,668m). Hawker's two-seat suggestion showed no change from its N.8/39 project.

Supermarine

The designers described the first of two projects as a 'Spitfire with Griffon engine'. It had folding wings and was offered as the most suitable aeroplane that could be put into production in a reasonable time. It was pointed out that the Spitfire had already flown with a 2,000bhp (1,491kW) engine and had handled quite normally. The second project was a Spitfire development with a Sabre which used the original wings, rear fuselage and tail but had a new centre section. The respective internal fuel capacities were 134gal (609lit) and 186gal (846lit) and RAE described these designs as 'an extremely neat job'. The original N.8/39 work was retained for the two-seater. (A drawing of the Griffon project can be found in *Spitfire – The History*).

Westland

Westland finally got to tender a design officially and the result was powered by a Griffon and carried 220gal (1,000lit) of fuel. Service ceiling was 34,000ft (10,363m).

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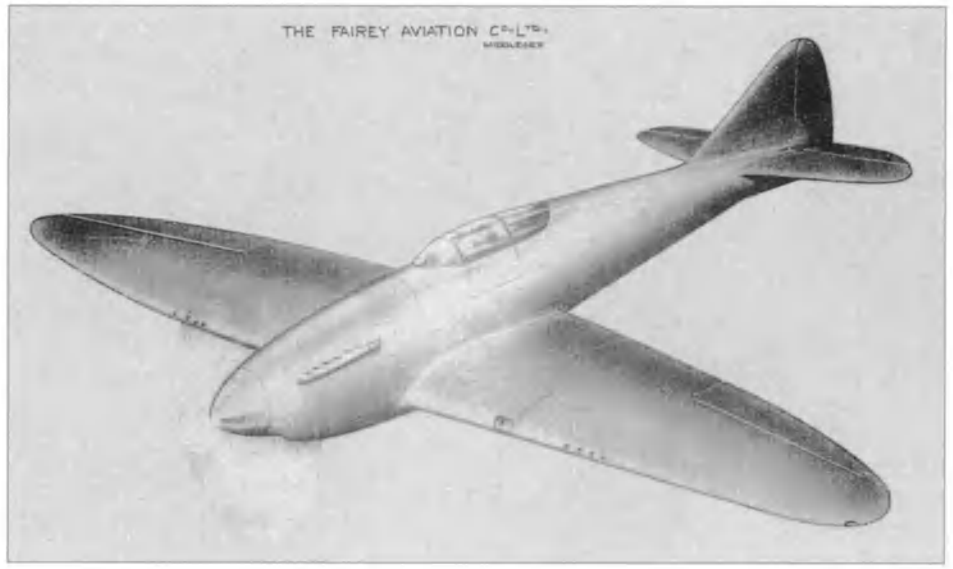
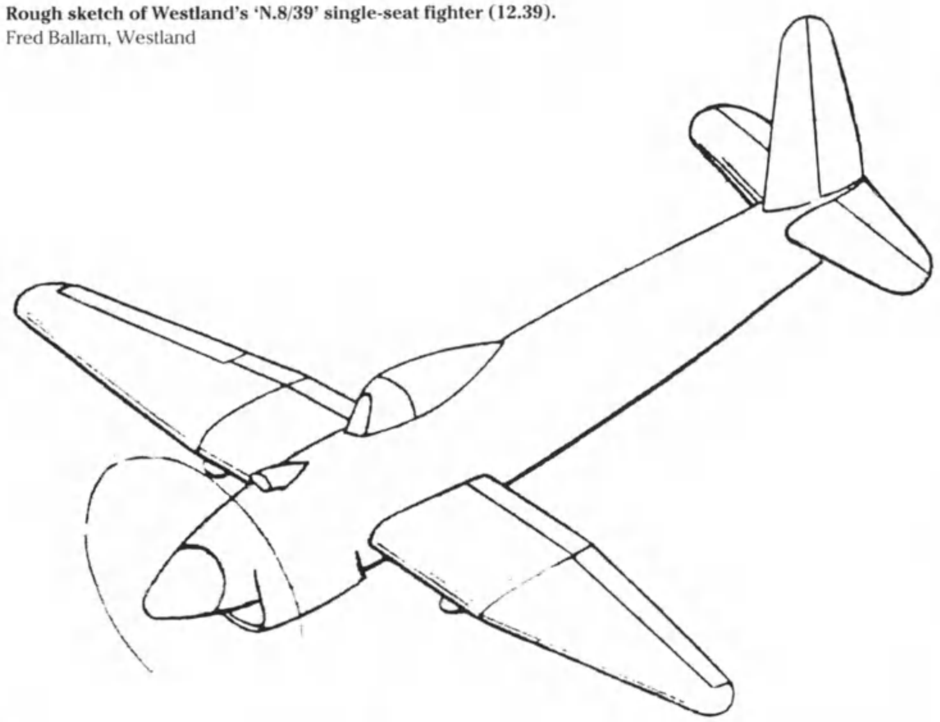
RDT re-estimated the weights and performance figures for this latest series of designs and, in most cases, the former went up and the speeds were lower (the Supermarine designs by 22mph to 37mph [35km/h to 60km/h]). However both Blackburn and Westland were expected to be lighter than estimated with the latter 8mph (13km/h) faster.

The Tender Design Conference for the original N.8/39 designs was finally held on 5th January 1940. Capt M S Slattery, Admiralty Director of Air Material (DAM), outlined the reasons for the recent changes to their requirements, which had originally been laid down before the war. The original tenders had been submitted after two months of war and it had now become evident that performance was paramount and that a fighter of low speed could not be countenanced. To obtain the desired performance, the navigation and radio facilities would have to be drastically reduced. It had also become evident that the linking of designs for front gun and


THE FAIREY AVIATION Cº Lᵀᴰ

Impression of the Fairey single-seat fighter.

Rough sketch of Westland's 'N.8/39' single-seat fighter (12.39).
Fred Ballam, Westland



turret fighters would have a serious effect on the design and the new series of single-seat projects (to NAD.925/39) had been invited primarily to give a datum for comparative purposes. If the tenders showed that little would be lost by imposing such minimum requirements for navigation, and if two designs could be selected as suitable for development, Slattery felt the purpose of the investigation would have been achieved. Production was desired in 18 months time.

Gloster's original design was reasonable and of relatively simple construction, Vickers was the 'cleanest' but, as noted, its stability was doubtful because of the small tail. There had not been sufficient time to thoroughly examine the latest single-seaters but the 'Griffon Spitfire' was regarded as 'closely approaching the Fairey design in technical merit'. However, the Spitfire's view was considered poor for deck landing while Fairey's tender to the modified two-seat requirements showed a 500lb (227kg) increase in weight and a loss of about 7mph (11km/h) in speed from the single-seater. The claimed 380mph (611km/h) top speed was regarded as optimistic but it was thought that this design showed better appreciation of the Admiralty's requirements than the others. Discussion established that the Fairey design was the most acceptable and least speculative of those submitted. However, concern was expressed that the placing of further FAA development work with Fairey could lead to the company undertaking an undue preponderance of such work, a position that might ultimately result in a lack of interest from other design staffs.

Therefore, it was felt necessary to make some provision for extending FAA aircraft design problems to as many companies as possible. The Blackburn design indicated a method of improved stalling speed which ought not to be neglected and it was considered that this scheme was worthy of a trial, even in wartime. War conditions had shown that less wind speed than expected was often available for operating aircraft and exhaustive discussions had indicted that the overriding factor controlling the designs was the stalling speed. Therefore it was decided to recommend that a small order for 25 aircraft should be placed with Blackburn as an experiment. The modified Fairey N.8/39 with Griffon engine was considered to be the most suitable project for service and it was thought that a production order could be placed 'off the drawing board'.

Early mark of Fairey Firefly with the original chin radiator.

WD850 was a specialist AS Mk.6 anti-submarine Firefly with the radiators moved to the wing and all of the wing guns removed.

Fairey Firefly

To avoid any confusion, on 24th February 1940 it was requested that N8/39 should be replaced by a new specification, N.5/40. Five days later the Admiralty requested approval for an order covering 200 examples of Fairey's fighter to follow the Fulmar. War experience had shown that they should concentrate on performance and speed but in March the Air Ministry advised that the two-seater policy was still in force because the speed discrepancy between single and two-seat types was quite small. Under normal circumstances the FAA's needs for a fighter differed from the RAF's – the Navy would know that enemy bombers had one objective, the fleet, while the RAF had to deal with bombers who may have several targets, each of them unknown to the defenders. Hence a large speed differential was less critical for the FAA and this would tend to disappear at high altitudes anyway. In addition, a large range was required to find enemy reconnaissance aircraft before they found the fleet, which would also give warning for extra fighters to get airborne before the bombers arrived. At this early stage of the war it was not expected that the new aircraft would have to meet enemy single-seat escort fighters because of the latter's restrictions in range.

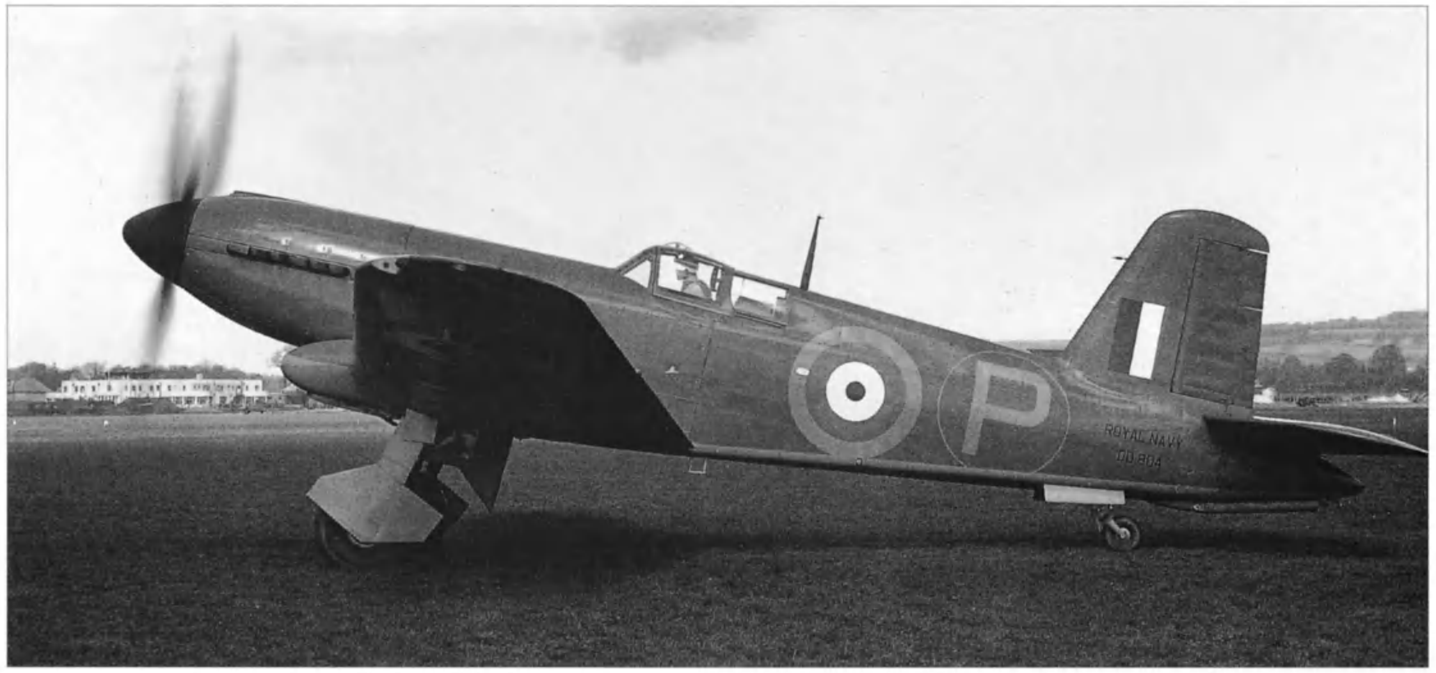
Thus, after a great deal of discussion it was confirmed that, for the normal and general functions of FAA fighters, the two-seater should be retained in preference to the single-seat alternative. Consequently, at the Advisory Design Conference held on 11th March, it was decided that Fairey's project should be a two-seater. The Mock-up Conference was held on 6th and 7th May and the contract was placed for the first order (for 200 aeroplanes) on 12th June. The first three machines, Z1826 to Z1828, were to serve as prototypes and the first made its maiden flight on 22nd December 1941. Named Firefly, a total of 1,702 production aircraft were built and the type served the FAA in several versions until the mid-1950s. The later Mk.4 lost its elliptical wing for a clipped version and had the radiators moved from the chin position into the wing leading edge.

Blackburn Firebrand

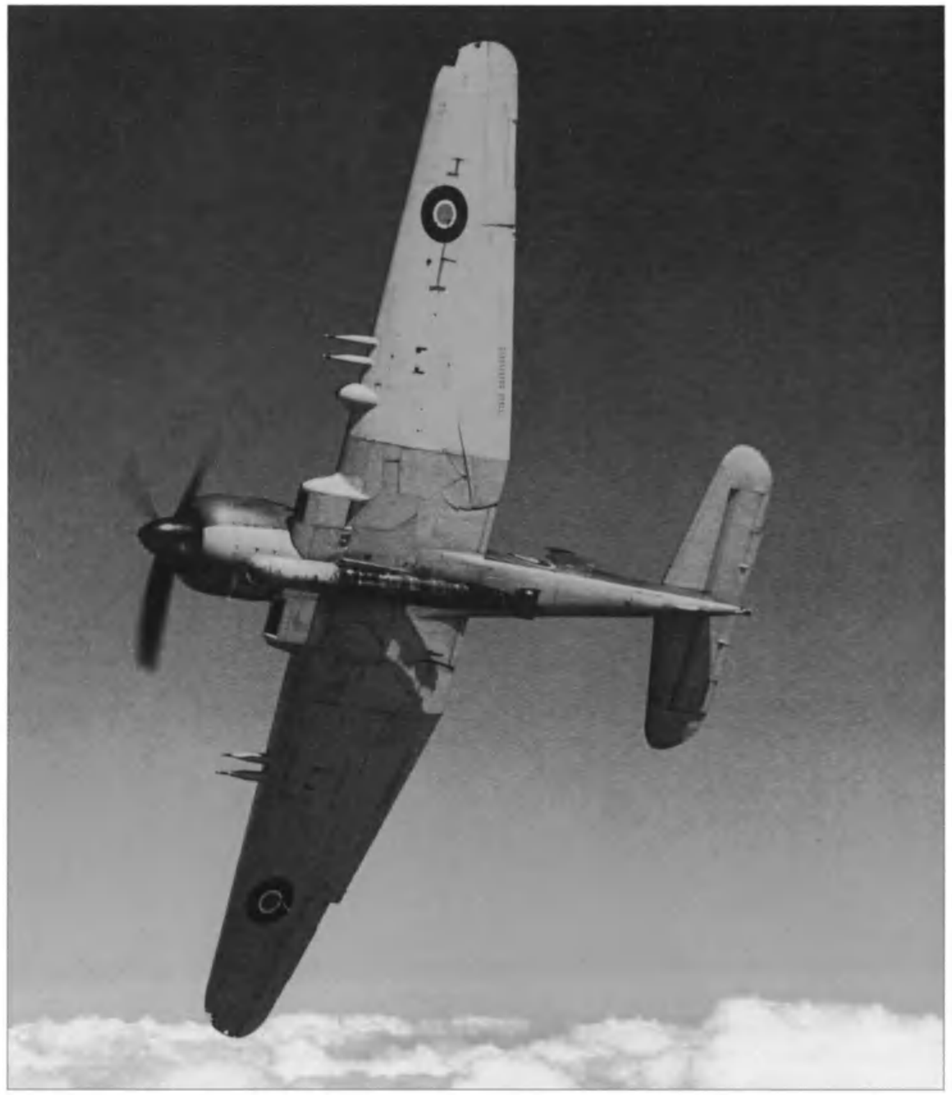
Experience, however, had shown that there were occasions when a single-seat fighter, with its generally superior performance, could be employed with advantage. These included the defence of naval bases or ships in harbour against shore-based enemy aircraft by an interceptor type. Constitutionally the defence of Fleet bases was an RAF commitment for which no provision had been made in the FAA programme, but the Admiralty now stated that in practice the FAA would have to perform much of this task itself. In addition the advantage of having a force of high-performance fighters which could readily be transported and operated in a carrier had been made clear by experiences in Norway during the spring of 1940. For this reason it was now proposed to introduce a limited number of high-performance single-seat fighters to Blackburn's B.37 design, which had an estimated top speed of 390mph (628km/h).

By 21st June 1940 the design had been approved by the Air Ministry's technical experts and, to speed delivery, it was proposed to order it 'off the board' without prototypes. Specification N.11/40 of 24th August was raised to cover the aircraft and stated that the minimum top speed had to be 350 knots (403mph/648km/h). The mock-up was examined in the autumn and three prototypes, DD804, DD810 and DD815, were ordered in January 1941. On 11th July 1941 the new aircraft was named Firebrand and DD804 was first flown on 27th February 1942 with a Sabre II. On trials it was found to be 32mph (51km/h) below Blackburn's maximum speed estimate but fitting a Sabre III brought the figure up to 358mph (576km/h) at 17,000ft (5,182m). However, problems, delays and doubts regarding the Sabre's development were to lead to a switch to the Centaurus.

The Firebrand was a large and heavy machine which, although possessing considerable endurance, in manoeuvrability suffered in comparison with lighter shipboard fighters. It was also to suffer many development problems and consequent changes to its role, before being turned into a torpedo bomber



Blackburn Firebrand prototype DD804 photographed on 2nd April 1942. BAe Brough Heritage



An unidentified Firebrand IV banks away from the camera to give a good view of its wing radiators and the cannon. BAe Brough Heritage

fighter (that is, a strike fighter) for which the centre section was widened to make room for a torpedo. The first order for fifty machines eventually comprised nine TF Mk.Is and twelve TF Mk.IIs, all with Sabres, two B.45 Firebrand TF Mk.III prototypes to Specification S.8/43 with Centaurus VII engines (DK372 first flown on 21st December 1943 and DK373) and the rest production Mk.IIIs with Centaurus. All of these were used for development and trials but they were followed by another 170 built to Mk.IV or Mk.V (B.46) standard which had many modifications including a larger fin and more powerful 2,520bhp (1,879kW) Centaurus IXs or 57s. After a long wait the Firebrand at last began to reach operational units in 1945; it served until 1953 before being replaced by the Westland Wyvern.

Hawker P.1009 'Sea Typhoon'

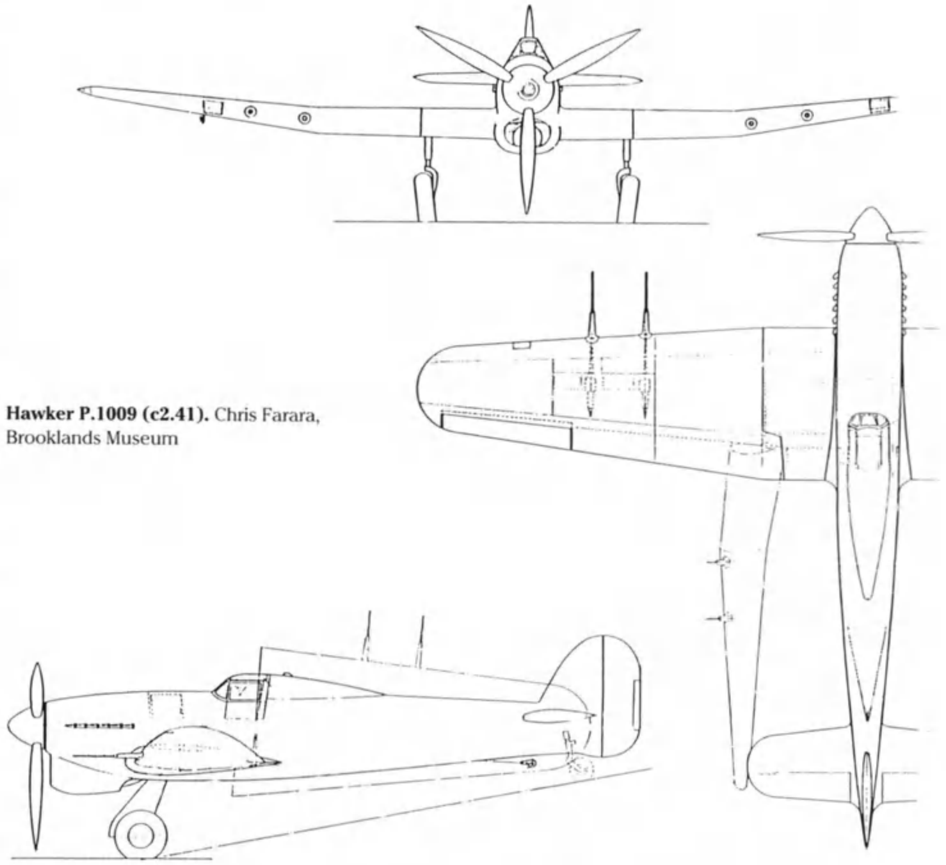
On 20th February 1941 delays with the N.11/40 Firebrand prompted the Admiralty to agree to examine a navalised version of the Hawker Typhoon, a 'Sea Typhoon', as an alternative. The result was the P.1009 variant converted to N.11/40 with larger folding wings and a fuel capacity of 264gal (1,200lit). However, A V Alexander told Lord Beaverbrook that he saw no hope of the Sea Typhoon being produced by the end of the year, even if the design work was done by Hawker. In addition a separate company would not have a prototype ready until late spring/early summer 1942, when the Blackburn was expected to fly in August/September 1941, so any Sea Typhoon prototypes would be some months behind, regardless of who built them. On 21st March 1941 it was decided that modifying the Typhoon would mean a major redesign of the aircraft. Some 25% of Typhoon parts might be used in the sea version but the result would be inferior in performance to the N.11/40 and less suitable for naval purposes, so it was unanimously recommended that production of the Blackburn N.11/40 should proceed in preference to the Sea Typhoon. In addition the RAF reported that the Typhoon was a good 'bomber destroyer' but lacked the manoeuvrability needed for combat.

A 'hooked' Typhoon or Tempest for carrier operation was considered again in November 1942. By then the Seafire (below) was in service which, although in many respects not meeting the Naval Staff requirements for a single-seat fighter, had proved valuable and was appreciated by far as the best fighter with which the Navy had yet been equipped. However, it showed certain disadvantages including a restricted view for landing and a lack of robustness, particularly in the undercarriage. The CinC Home Fleet wrote on 28th November that the new Hawker aircraft were less handicapped in these respects. 'The view over the Sabre engine is better [and] these aircraft are also built with all of the traditional strength of Hawkers; the undercarriage seems especially strong.' He suggested that a Typhoon or Tempest should be obtained for Admiralty use as soon as possible and hooked for trials.

He added that 'it must be remembered that these aircraft are cart-horses, being pulled along by immense engines while Vickers (Supermarine) products are more of the racehorse class', but acknowledged that the size of these aircraft would control the numbers that could be put onto a carrier. Discussions continued and a Typhoon IB, DW419, was allocated, but crashed on 8th February 1943. Finally, on 23rd December 1943 Capt Casper John declared that the Typhoon was difficult to use as a carrier fighter, largely because of its long take-off run and high stalling speed. The control of its stalling speed was nothing like as good as that of the Seafire and the Typhoon test pilot, Lt Cdr Campbell, felt the Firebrand (shortly to begin its initial deck trials) would be a better aeroplane to and from the deck.

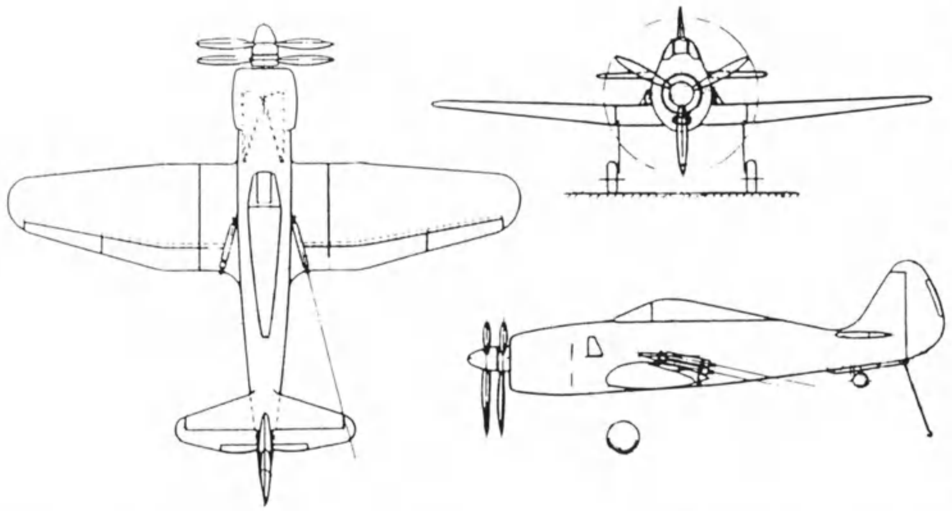
Supermarine Seafire

As an intermediate step between the Fulmar and its N.5/40 replacement, the Admiralty also decided to pursue the possibility of obtaining a number of 'Spitfires' with folding wings and an arrester hook. The Sea Lords were anxious that a fighter of higher performance should be brought into service as early as possible and the feasibility of fifty Spitfires so modified had already been discussed informally. The idea was officially put to the Air Ministry on 29th February 1940 but the project was dropped on 29th March, a key reason being that the construction of a certain quantity of 'Sea Spitfires' would reduce the number of land Spitfires coming off the lines by a much greater figure, aircraft that would be desperately needed by the RAF. The gap was to be partially filled by the acquisition of the American Grumman Wildcat fighter which entered FAA service in late 1940 as the Martlet.

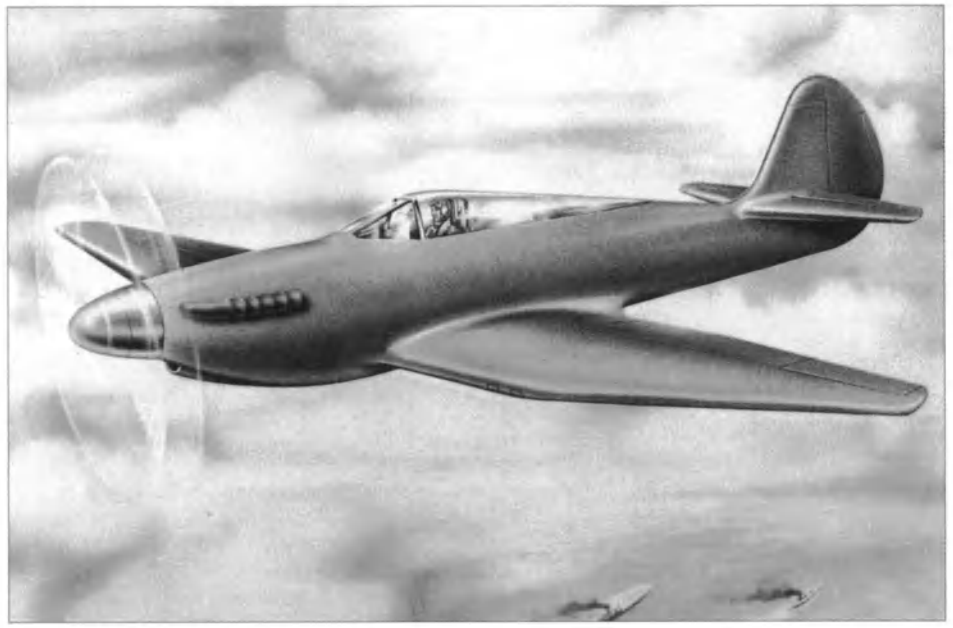


Hawker P.1009 (c2.41). Chris Farara, Brooklands Museum

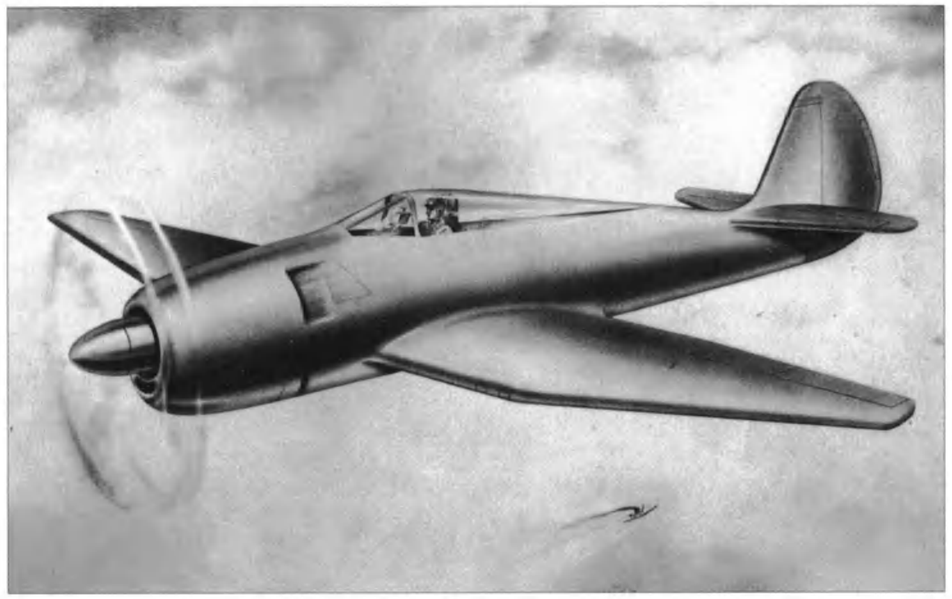
Supermarine Seafire Mk.46 LA542.



Boulton Paul P.103B with take-off rocket gear on upper wing (4.43). Les Whitehouse



Artist's impressions of the P.103A. Les Whitehouse



Artist's impressions of the P.103B. Les Whitehouse

However, the idea of a 'Sea Spitfire' did not go away and in the second half of 1941 some were ordered. Initial deck landing trials were made towards the end of that year and the first squadrons received their aircraft in 1942. In due course there were to be both Merlin and Griffon-powered Seafires and the type stayed with the FAA until 1954.

Specification N.7/43

The navy's search for a top class single-seat fighter continued and during early spring 1943 some unofficial design studies for a fleet fighter were submitted by a number of companies; these brought a review of some new draft requirements which had recently been drawn up. The navy's Design Committee realised that if the fleet interceptor fighter was to have the necessary very high performance to enable it to compete with shore-based fighters, it would be necessary to keep the endurance, ammunition and so on, as low as possible. The normal permanent fuel load was cut to give just 1¾ hours at maximum cruising speed rather than the 2¼ hours previously desired. The resulting specification, N.7/43, brought several formal submissions.

Boulton Paul P.103

There were two versions, the P.103A with a Griffon and the Centaurus-powered P.103B, both using contra-rotating 'dive brake' propellers. P.103 featured a low-drag wing and a rocket-assisted take-off facility on the upper wing centre section, plus a number of innovative features such as an undercarriage which was long enough to ensure that the airscrew had sufficient ground clearance but became shorter when it retracted. The elevator had automatic trim tabs and an American-style sting arrester hook was fitted. Internal fuel was 160gal (728lit) and folded width 13ft 10in (4.23m), maximum speeds at sea level 366mph (589km/h) and 365mph (587km/h) respectively. Some special features generated much interest and Defiant DR895 was later adapted to try some of them out.

Boulton Paul P.104

A tail-first single-seat fighter fitted with a pusher RG.5.SM Griffon. It is possible that this was designed around the P.100 ground attack aircraft (Chapter 4) but no details survive.

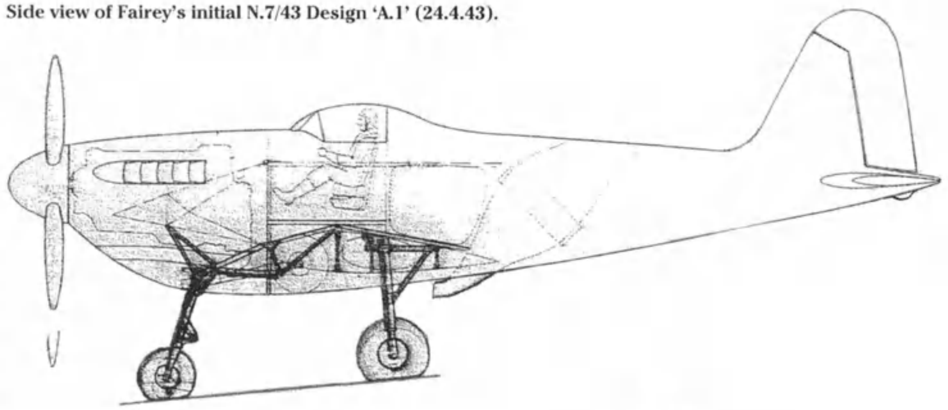
Fairey N.7/43

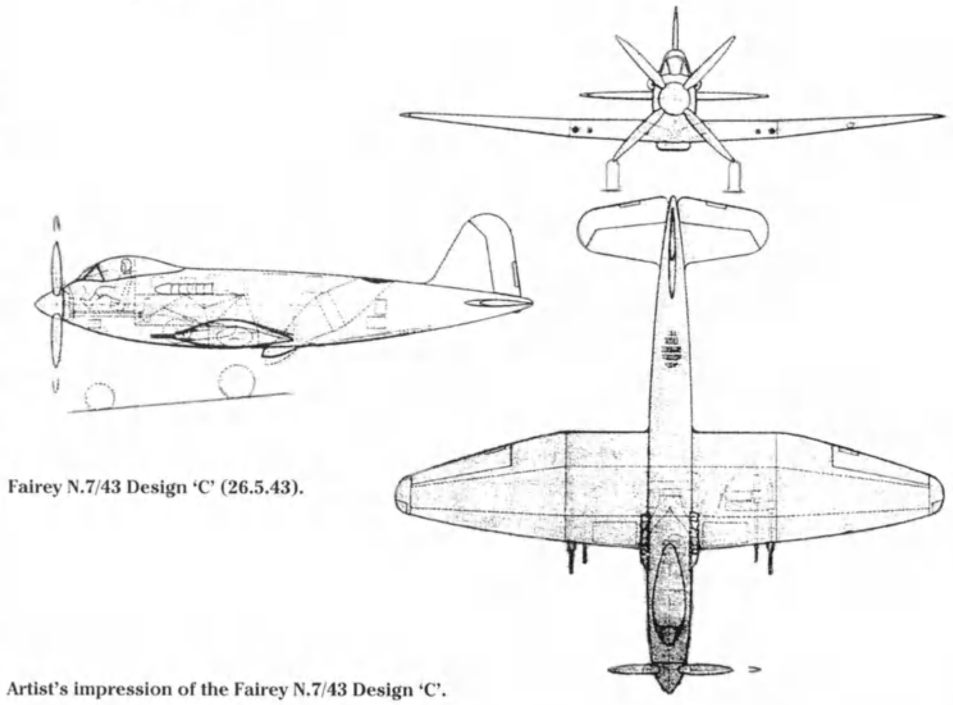
Pilot view on the approach was considered by Fairey as a key element of the project and Part I of Fairey's studies (dated 24th April 1943) centred on a conventional design called A.1 with a single 2,100bhp (1,566kW) Griffon 61, a tricycle undercarriage and, possibly, a variable-incidence wing; Fairey acknowledged, however, that the latter could become quite complicated. All-up-weight was 12,000lb (5,443kg), maximum speed 337mph (542km/h) at 1,000ft (305m) and time to 5,000ft (1,524m) 2.17 minutes.

Part II (of 10th May) introduced a dual power unit comprising one Rolls-Royce Peregrine piston and one Whittle jet, which offered a much higher top speed. Both engines would be used for take-off, climb and combat but the piston only would run during cruise. Described as a simple design with stressed skin construction (with thicker skins for a superior surface finish), it was hoped that the speed could be achieved without resorting to any aerodynamic or structural developments. The Peregrine had a relatively small radiator and the cooling air for this, together with all of the air for the jet, would be ducted in from the nose. Sea level speed was 418mph (673km/h), time to 10,000ft (3,048m) 2.67 minutes, range 745 miles (1,199km) and service ceiling 41,000ft (12,497m). For comparison an alternative with a single 4,000lb (17.8kN) jet had also been assessed and this offered an equal top speed but a much smaller range.

On the advice of DTD a revised A.1 was completed on 26th May with the Griffon moved to the centre fuselage so that the pilot was seated ahead of the engine behind a tractor airscrew, which was driven by a high-speed shaft from the engine. This gave the pilot an near optimum view over the airscrew spinner. On this variant, called Design C, the fuselage forward of the wing was extended some 30in (76.2cm) compared to the A.1 but in most other respects it was similar, including the cannon position in the centre plane and the tricycle undercarriage. The radiators were positioned behind the engine and main fuel tank and the folded span was 16ft (4.88m). Finally, on 7th June Fairey completed Part III which was essentially a blending of the A.1 together with a dual powerplant of one Merlin and a Whittle jet. A speed of 447mph (719km/h) at sea level was estimated, 2.75 minutes to 10,000ft (3,048m) and ceiling 42,000ft (12,802m). A version was also suggested for the RAF but on 20th June Fairey received a letter from DTD requesting that the company's work on single-seat naval fighters should now cease.

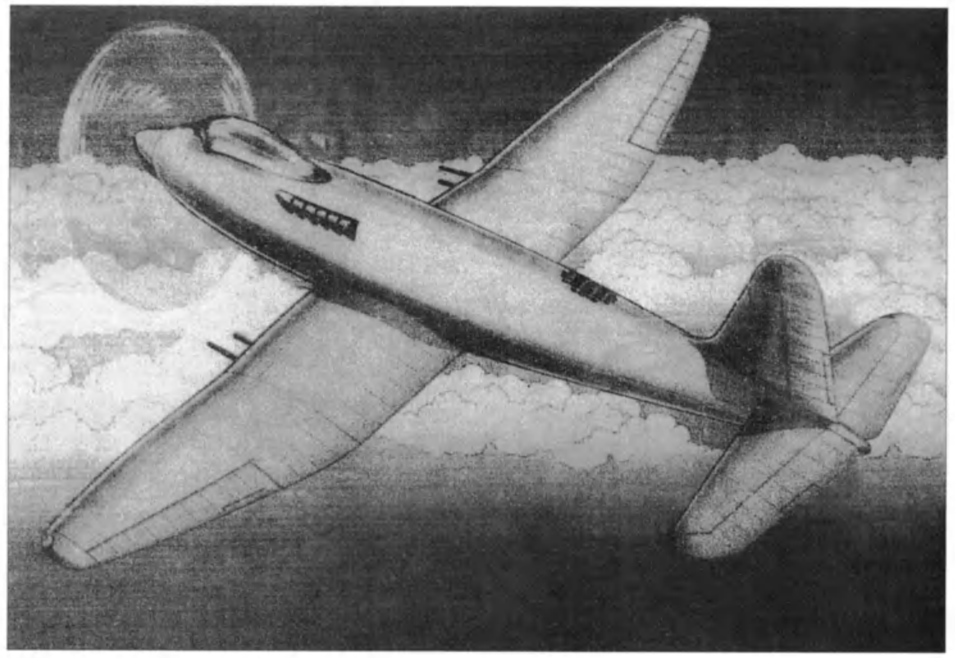
Side view of Fairey's initial N.7/43 Design 'A.1' (24.4.43).

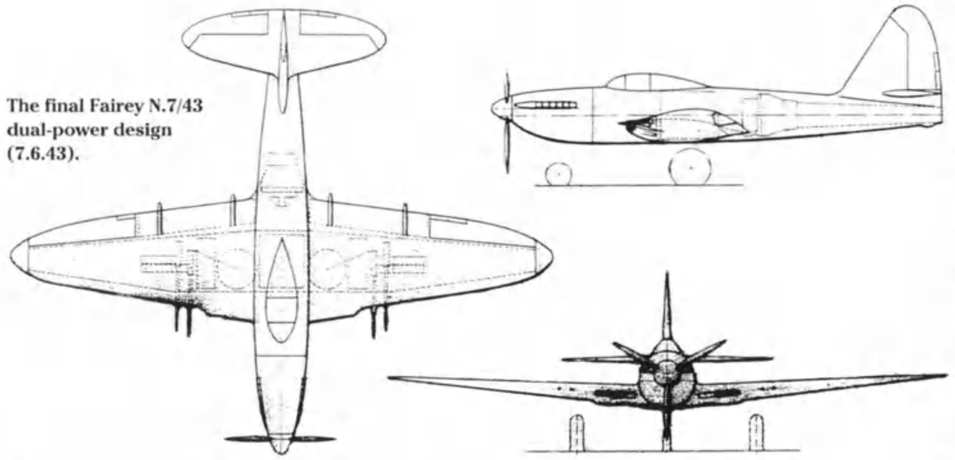


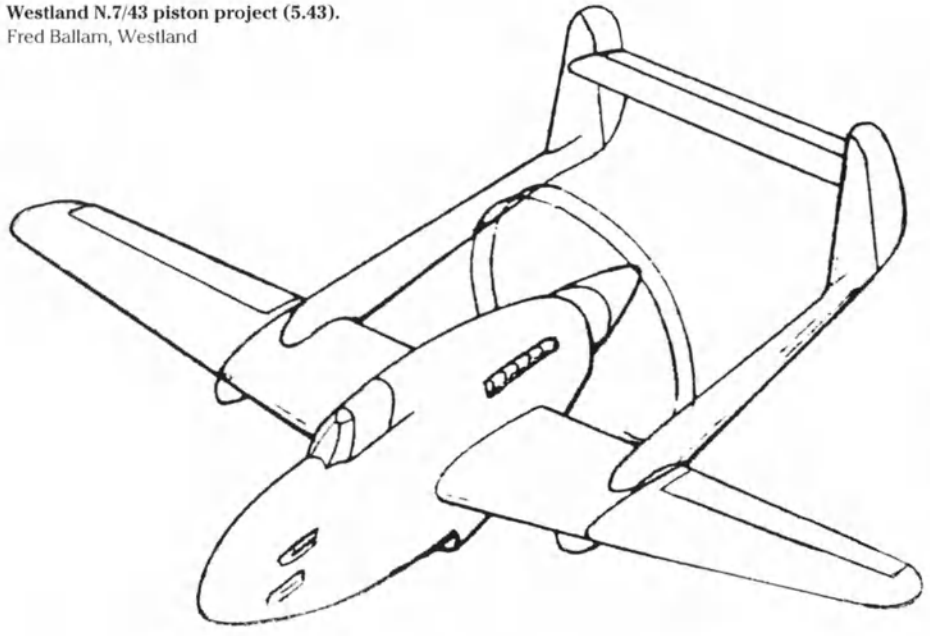


Fairey N.7/43 Design 'C' (26.5.43).

Artist's impression of the Fairey N.7/43 Design 'C'.




The final Fairey N.7/43 dual-power design (7.6.43).


Westland N.7/43 piston project (5.43).
Fred Ballam, Westland

The semi-navalised Sea Fury prototype SR661 first flew on 21st February 1945.

Folland Fo.118

This was a version of Folland's original Fo.117 project to F.6/42 (Chapter 1) fitted with a Centaurus. The Ministry gave the potential performance of this aircraft as 394mph (634km/h) maximum at sea level and 469mph (755km/h) at 20,000ft (6,096m), all-up-weight 11,042lb (5,009kg).

Hawker P.1022

A development of Hawker's work to F.6/42. The Ministry's estimated performance for this aircraft was 437mph (703km/h) at 21,000ft (6,401m), all-up-weight 11,140lb (5,053kg).

Westland N.7/43

Two similar twin-boom pusher designs were proposed by Westland in May 1943, one with a Griffon and the other with a Halford H.1 jet (the latter was a heavier navalised version of the J.15 to be described in Chapter 11). The piston project had wing folding, a tricycle undercarriage and also introduced pilot ejection.

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CNR noted that it would be reasonable to order the conventional tractor class of designs 'off the drawing board' whilst the alternative pusher, buried engine or conventional plus jet layouts could only be considered in terms of building prototypes (although the piston/jet combination might be suitable for naval application and a pusher type would give an excellent pilot view). Of the conventional proposals the best performances were offered by Folland and Hawker, both adaptations of designs for new RAF fighters, and the Folland appeared to be slightly the better, but this company did not have the resources to put an aircraft into large-scale production. It was felt that there would be many advantages in the new naval interceptor being a modification of the best RAF type and this policy was accepted by the Ministry. As described in Chapter 1, Folland's Fo.117 was abandoned and in due course the Hawker Sea Fury was selected for FAA service under N.22/43.

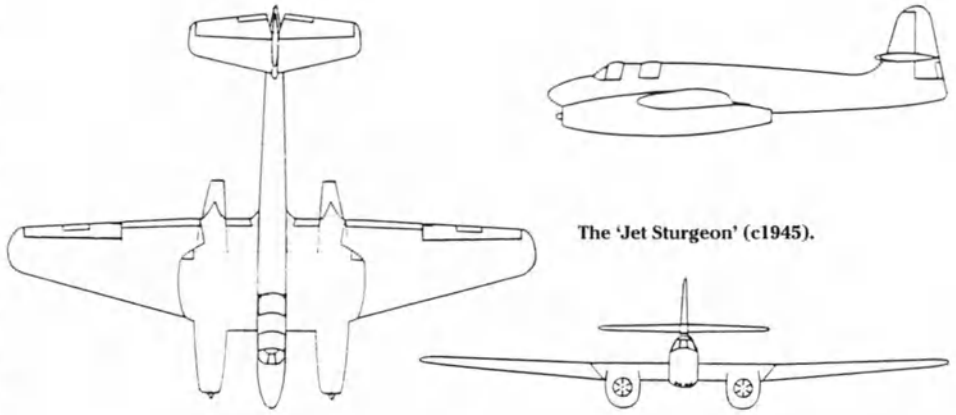
De Havilland Sea Hornet

With the supreme level of power available to the RAF's Hornet, it seemed a logical step to exploit its potential in a naval version. The FAA needed to re-equip with a modern aircraft while the Hornet's handed propellers would be most helpful for carrier operations. After the Admiralty had revealed its interest Specification N.5/44 of 15th July 1944 was raised to cover a naval long-range fighter variant with Merlin 130/131, war load, top speed and climb rate unchanged from the RAF version. The principle changes for the Sea Hornet included hydraulic folding wings, an arrester hook, rocket-assisted take-off accelerator gear and the replacement of the Hornet rubber-in-compression main legs with Airdraulic shock absorber legs. The Airdraulic chassis brought a weight penalty but was necessary to eliminate bounce on carrier landings; the RAF Hornet's rubber leg could not quite absorb the energy at the high rate of descent allowed on carriers. Navalising the Hornet added 550lb (249kg) of weight and Heston Aircraft was entrusted with the detail design of the naval modifications. Eventually seven RAF Hornets were modified as prototype F Mk.20s and the first, PX212, flew on 19th April 1945.

The next Sea Hornet fighter variant, the NF Mk.21, brought some changes to the type's external appearance. So urgent was the Navy's need for up-to-date high-performance aircraft that Specification N.21/45 was written around a Sea Hornet night fighter to replace the Fairey Firefly. To perform this role the aircraft would need an observer and employ drop tanks to increase its range to over 1,300 miles (2,092km). A night fighter mock-up was examined on 22nd May 1945 and the mark would have the same weapon load and engines (although many aircraft actually had Merlin 134/135s); the engine's exhausts would be screened for night flying.

There was concern that the full equipment needed for night fighting might not fit inside the airframe but the only alternative would be a version of the Short S.11/43 Sturgeon (Chapter 9) developed for the role. However, while it was possible that the Sturgeon would be more lavishly equipped, there was no doubt that its performance would fall far short of the Sea Hornet and far short of the minimum required. Nevertheless, in June Shorts were asked to consider the design of a night fighter based on the Sturgeon and on 4th July the Assistant Chief of the Naval Staff (Air), (ACNS[A]), stated that the result 'would be very different from the Sturgeon in having more powerful engines which would be so installed that the arcs covered by the A.1 scanner (an essential feature of the night fighter) would be very much increased over what would be possible in the existing S.11/43'. At this stage the Sturgeon was still to fly but ACNS(A) concluded that he proposed to approve:

i. that the future of the S.11/43 should be considered after the prototype had flown.
ii. the investigation of a night fighter based on the S.11/43 as an insurance in case the night fighter Sea Hornet proves more difficult to land on a deck at night than is expected.
iii. the development of the Sea Hornet night fighter to the prototype stage.


The 'Jet Sturgeon' (c1945).

Short 'Jet Sturgeon'

An undated drawing is available for a Short Brothers Fleet Air Arm Night Fighter. There is no documentation linking it to the Sturgeon or the Sea Hornet but it seems most likely to be the result of the June 1945 request for such a design. Clearly based on the Sturgeon, with the same wings and a similar body and empennage, the Merlins had been replaced with two Rolls-Royce AJ.40 jets and the tail moved higher on the fin to keep it clear of the jet exhaust. Four 20mm cannon were mounted in the lower nose and there were nine fuel tanks, six in the wings taking up the space vacated by the leading edge radiators and three in the fuselage behind the cockpit; total capacity was 910gal (4,138lit). (Author's note: Published sources state that the Short S.41/S.A.3 project was prepared to Specification N.7/46, which covered the Hawker Sea Hawk. This drawing may be the S.41 but it gives no project number.)

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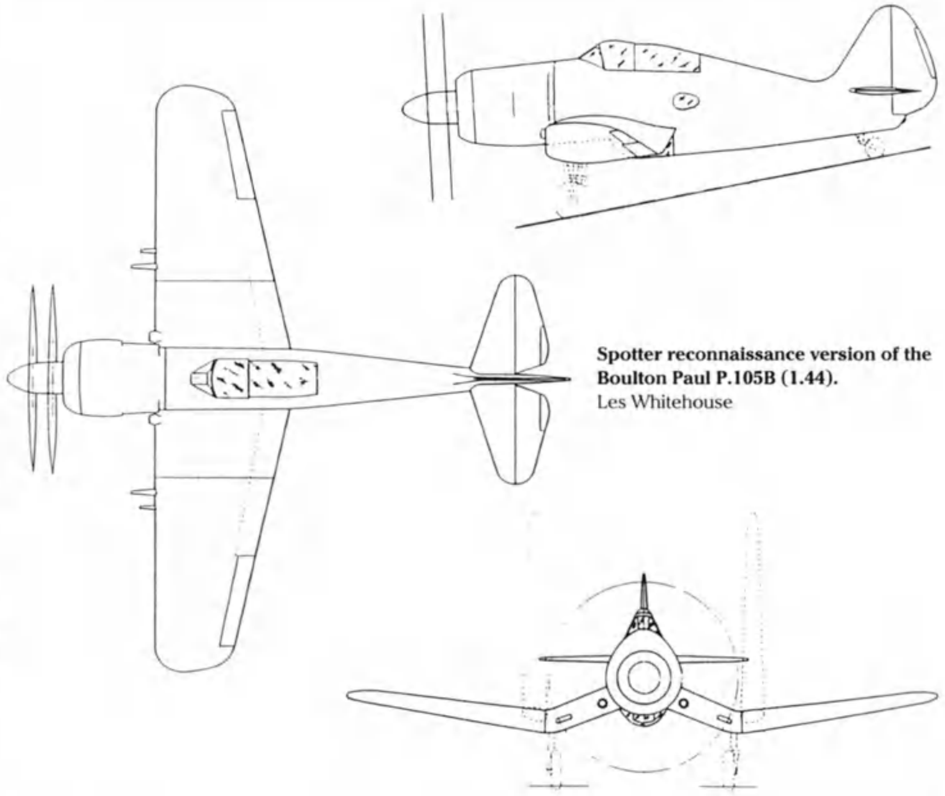
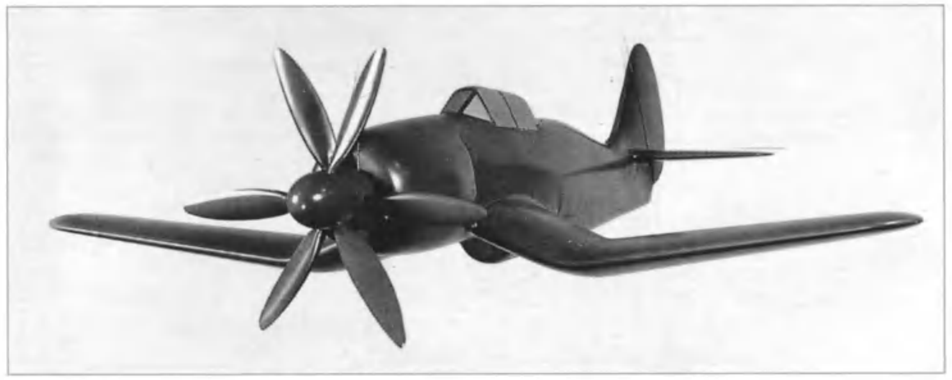
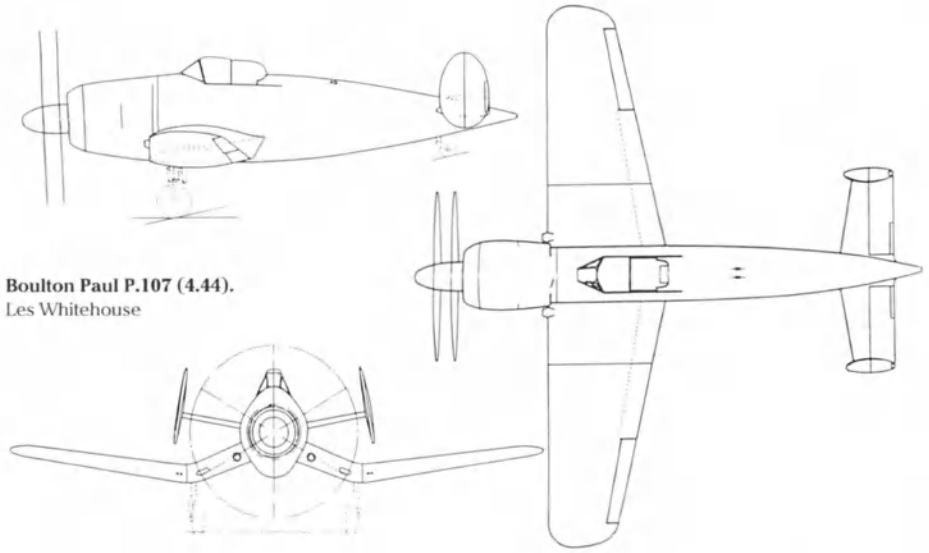
The Shorts Night Fighter was never ordered and the prototype Sea Hornet Mk.21, PX230,


Spotter reconnaissance version of the Boulton Paul P.105B (1.44).
Les Whitehouse



Model of the P.105.
Alec Brew (Boulton Paul Association)



Boulton Paul P.107 (4.44).
Les Whitehouse

first flew on 9th July 1946; it featured a new dorsal cockpit behind the pilot where the observer could work the radar. The eventual 'thimble' shaped radome on a longer nose was selected after several other styles were rejected and test flights showed that the alterations to the external shape had cost just 5mph (8km/h) of speed over the Mk 20 with handling near identical. The last Sea Hornets were withdrawn in 1955.

Strike Fighters

Towards the end of the war the Fleet Air Arm began a search for a strike fighter. A tendency to combine the duties of the bomber and fighter led to the development of a number of such designs which were capable of carrying heavy offensive loads over long distances and then, after reaching and attacking their objectives, having a performance equal to that of contemporary fighters. The projects described in the remainder of this chapter were not totally related but they group together very neatly in one section.

Boulton Paul P.105

J D North, Boulton Paul's designer, continued his naval studies with this project for a multirole design. The intention was to provide the smallest possible high-performance naval carrier-borne aircraft which could undertake, by quick conversion (if necessary on the carrier itself), either torpedo bombing (P.105A), bomber, reconnaissance (P.105B) or escort fighter (P.105C). The idea was to have one basic airframe plus several modules, made up of new underbelly or cockpit sections, for role conversion. Thus a greater number of this small aeroplane and its compact conversion units could be housed in a carrier than contemporary types, thereby increasing the number of aircraft available for the diverse operations to be performed. Boulton Paul declared that this aircraft's very high performance would ensure an effective penetration of enemy defences. However, before any detailed performance estimates were completed it was decided to replace the original Griffon 61 with the Centaurus (fitted with a contra-rotating reversible-pitch propeller). Folded width was 15ft 4in (4.67m), internal fuel 260gal (1,182lit), top speed at sea level (as a fighter) 407mph (655km/h) and initial rate of climb (at 14,000lb [6,350kg] overload) 3,660ft/min (1,116m/min). The full brochure was submitted to DTD but not taken up.

Boulton Paul P.107

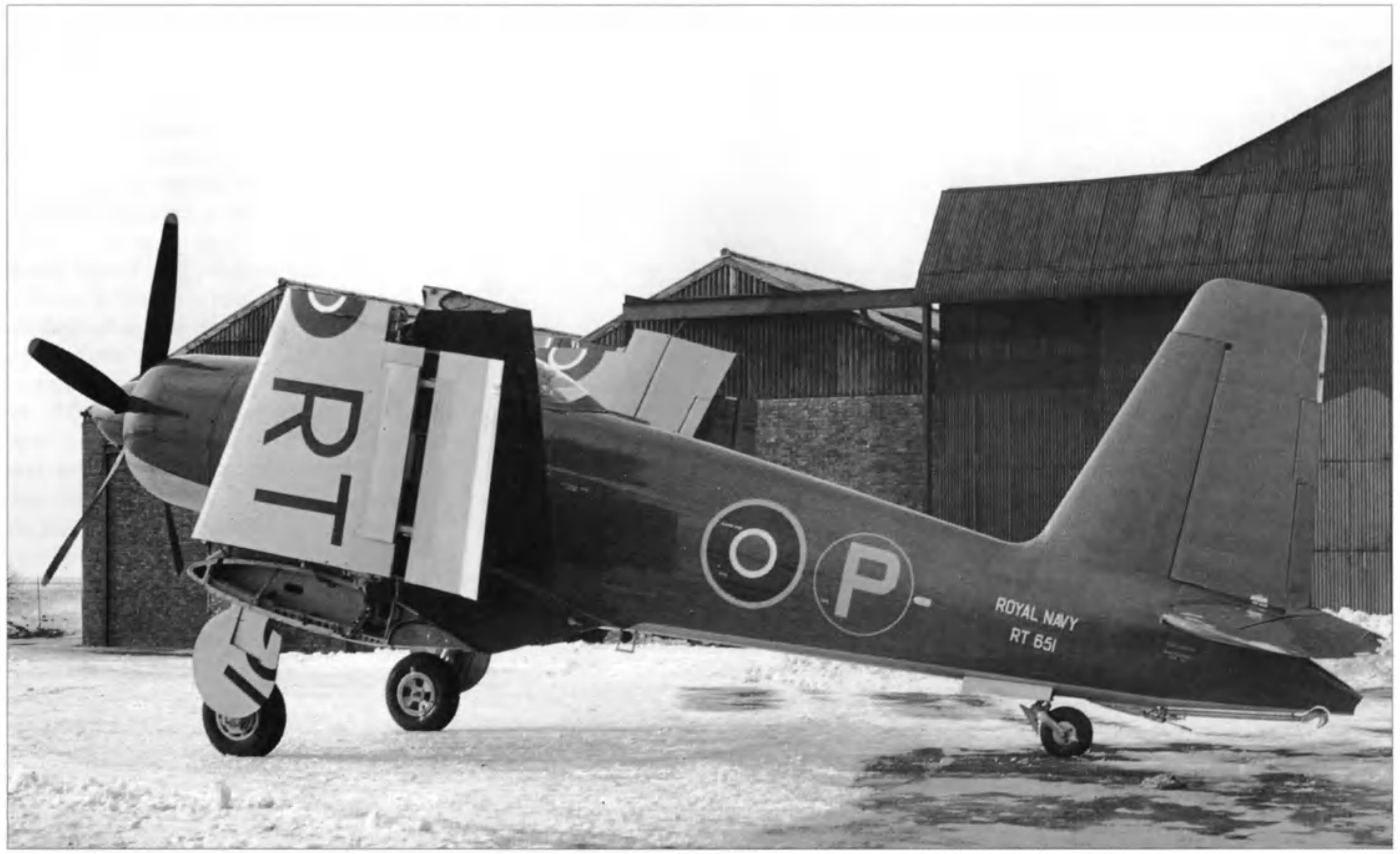
This was a pure landplane two-seat long-range escort fighter derivative of the P.105 which introduced twin fins and rudders and a rear gun station and had the torpedo blister removed. It could also be converted for photo reconnaissance and fighter bomber duties and, although not belonging to the naval fighter category, followed the P.105 very closely. Sufficient fuel (495gal [2,251lit] internal plus 140gal [637lit] in two drop tanks) was carried to give a range of 3,000 miles (4,827km) plus thirty minutes combat; without drop tanks the range was 2,200 miles (3,540km). There was a fixed forward armament (four 20mm) plus two rear defence 0.5in (12.7mm) remotely-controlled 'free' guns (housed completely within the fuselage except for the ends of the barrels) and the latter's field of fire was considered adequate to deal with a rear attack. Some of the fuel could be substituted with 2,000lb (907kg) of bombs to give a fighter bomber with a range of 700 miles (1,126km). A six-blade contra-rotating propeller was fitted.

Blackburn B.48 'Firecrest'

Blackburn spent much of the war working hard to develop and perfect its troublesome Firebrand. Air Marshal Linnell, CRD, wrote as early as August 1942 that future plans for the Firebrand were to try and 'develop it into something useful' and one line of development by George Petty's design team brought a new aircraft. The Blackburn B.48, unofficially known at Brough as the Firecrest but always called in official circles by its specification number S.28/43, was a full redesign of the Firebrand but it was not to progress beyond the prototype stage.

The first ideas to incorporate new laminar flow wings were discussed in September 1943 and it was estimated these would increase speed by about 13mph (21km/h) and cut wing weight by 700lb (318kg). Later it was decided to extend the scope of development and S.28/43 evolved from collaborations between Ministry and manufacturer. A redesigned fuselage with the pilot raised and moved forward relative to the engine resulted in a much improved view while a contra-rotating propeller was included which Blackburn used to reduce the rudder power, the Firebrand's rudder size having been determined by the need to control swing on take-off. The opportunity was also taken to eliminate other undesirable features and, with a simplified structure, a saving in structure weight of some 1,400lb (635kg) was achieved, which allowed another 70gal (318lit) of fuel to be carried while still operating at a gross weight around 900lb (408kg) less than the Firebrand. The Hawker Tempest's windscreen and blister hood were also adapted for the new aircraft.

A decision to proceed with two Centaurus-powered prototypes was made on 11th November 1943 and the aircraft was designated Blackburn Y.A.1. It was seen as a valuable type because it would be able to do a certain amount of steep dive bombing work beyond its fighter role, but estimates for a spring 1944 first flight were to prove opti-



Prototype 'Firecrest' RT651 shows the aircraft's wingfold mechanism in the snows of 1947.

View of the Blackburn S.28/43 'Firecrest' prototype VF172 taken on 3rd February 1949.
Both BAe Brough Heritage

mistic. As work proceeded, proposals were made for alternative engines while competition was also forthcoming from other types like the Wyvern (below). In January 1945 Blackburn supplied a brochure for installing a Napier E.122 NS.79.SM, a development of the Sabre, which looked attractive, and on 14th March a go-ahead was given for three E.122 prototypes plus a third Centaurus machine. The Ministry felt this work would enable Blackburn to learn up-to-date techniques of design in aerodynamics and structures, while the E.122 project would support a reasonable programme of development at Napier.

In March 1945 the Sabre project was expected to have an all-up-weight of 16,641lb (7,548kg), maximum rate of climb 2,740ft/min (835m/min) at 7,500ft (2,286m), take 3.8 minutes to get to 10,000ft (3,048m) and have a ceiling of 34,500ft (10,516m); in June the estimated top speed in the fighter role was 403mph (648km/h) at 19,000ft (5,791m). Specification S.10/45 was raised to cover the Sabre Firecrest and N E Rowe considered that this aircraft and the piston-engined Westland N.11/44 Wyvern were vital to the Navy. To date the S.10/45 was the only aircraft envisaged to take the E.122 and this was an added incentive for production. On 12th June it was agreed that construction of the S.10/45 prototypes should be 'energetically pursued', but a final decision on the version's production would come later.

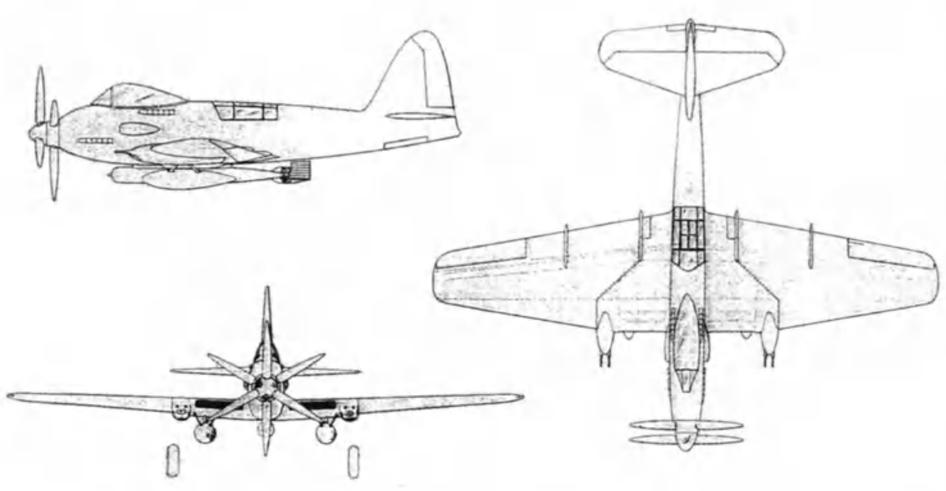
However, it was eventually discovered that the overall balance of the Sabre Firecrest was too far forward and the design could only proceed if the engine was placed behind the pilot with a shaft drive to the propeller in the nose. This entailed some major redesign and, coupled with an increase in weight of 1,000lb (454kg), helped to bring the cancellation of the Sabre project on 8th October 1945. In addition, on 10th August during Admiralty staff discussions, the S.10/45 had been described as a post-war project which will be in competition with other projects and limited funds. On 16th September it was agreed that the S.10/45 fell short of staff requirements and so was neither justified nor sound policy. It was proposed that the project be dropped and that Blackburn should be asked to produce a single-seat strike aircraft that would meet all of the Navy's new requirements.

In mid-1946 brochures were offered for Firecrests fitted with Proteus, Clyde or Python propeller gas turbines. These were collectively designated Y.A.6 and B.62 and generated much interest within the naval staff, who was keen to encourage them because it saw the aircraft as a useful hedge against failure of Westland's N.12/45 Clyde-powered Wyvern. With its lower all-up-weight and smaller dimensions, the Blackburn could also operate from the Navy's older carriers without modifications being made to their lifts and arrester gear. Blackburn's preliminary estimates suggested that the Proteus would have an all-up-weight of 16,174lb (7,337kg), sea level rate of climb 4,440ft/min (1,353m/min), service ceiling 41,000ft (12,497m) and top speed 423mph (681km/h); the Python' figures were 16,530lb (7,498kg), 4,260ft/min (1,298m/min), 40,000ft (12,192m) and 442mph (711km/h), the Clyde's 16,406lb (7,442kg), 4,255ft/min (1,297m/min), 39,000ft (11,887m) and 410mph (660km/h). However, to some extent these projects were viewed as test beds and also new aircraft, with the extra design work that that entailed, and so they were not adopted.

The Centaurus Firecrest continued but in January 1946, during final design work, development on the Centaurus 77 with its contra-propellers was stopped, which forced the substitution of a Centaurus 57 type to give the required power. This also meant a redesign of the fin and rudder to increase their combined area from 33ft^2 to 41ft^2 (3.1m^2 to 3.8m^2) and the new engine itself needed special flexible mountings; in this form it was redesignated Centaurus 59.

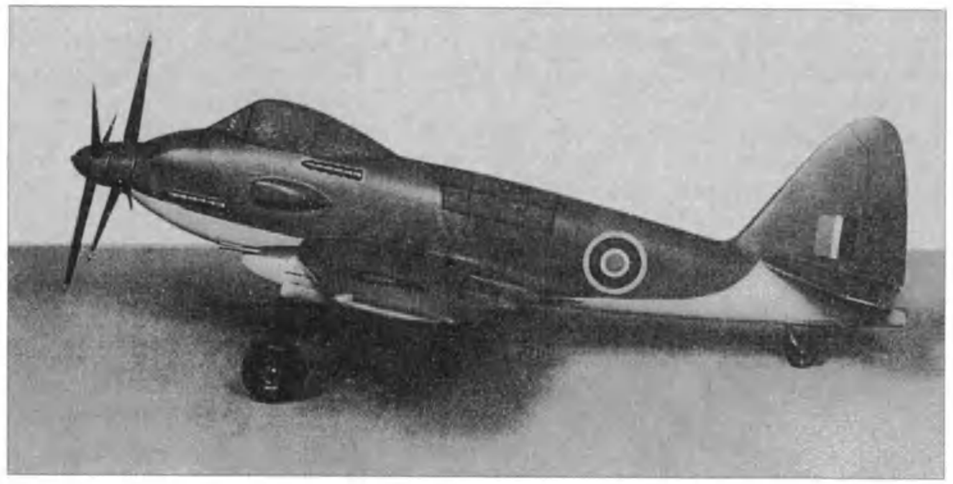
The Firecrest suffered long delays before its first flight and then the end of the war removed much of the urgency behind the programme. On 18th February 1947, in the snow of that year's dreadful winter, the first prototype RT651 was finally rolled out for engine testing and on 1st April it made its maiden flight. The second machine was RT656 and the third, ordered together with the Sabre aircraft, VF172. However, in September 1946 S Scott-Hall at the Ministry of Supply revealed that the type would need strengthening to make it acceptable as a strike fighter. Considerable redesign was necessary to produce a weight and performance similar to the Wyvern and the aeroplane would thus be a second string to the Westland machine at a considerable expenditure in design effort. Thus by the time the Firecrest became airborne its chances of production were gone, although no decision had been reached officially.

On 10th November 1947 the MoS requested that flying should cease, but a week later VF172 was reinstated to examine power-operated ailerons. In mid-1947, following discussions with RAE, Blackburn had concluded that the comparatively thick laminar flow section gave rise to speed variations and non-linear hinge moments that were very difficult to surmount by aerodynamic balance. To improve lateral control Blackburn felt that satisfactory forces throughout the speed range could be achieved by power control with artificial feel, so in October VF172 had power operation components fitted to the elevator and rudder. Flight testing had also shown that it would be beneficial to reduce the dihedral and VF172 was completed with just 3° of outer-wing dihedral. This aircraft began prototype flight tests on 6th February 1948 and the power control trials which followed produced some valuable general information. On 14th April 1950 RT651 and VF172 were sold to Blackburn to be broken up; RT656, which never flew, lasted into 1952.



Fairey Strike Fighter 'Project A' with Tandem Merlin powerplant (27.9.44).

Poor quality but unique illustration of a model of the Fairey Strike Fighter of October 1944.



Fairey Strike Fighter

As noted in Chapter 9, in August 1944 Fairey was asked to assess the possibilities of its tandem twin-engine studies being applied to a naval strike aircraft. A brief verbal statement of the requirements was given and in October a full tender with a twin Tandem Merlin powerplant (called Project A) and a slightly larger alternative Twin Griffon arrangement (Project B) was submitted. The design was primarily intended to be a single-seater, although there was the possibility of fitting a rear compartment for an observer. The engine arrangement was precisely similar to the Fairey O.21/44 torpedo bomber (Chapter 9) and had contra-rotating propellers. Two cannon were housed in each of two wing 'nacelles' (which also contained the main undercarriage), one torpedo or a 2,000lb (907kg) or 1,600lb (726kg) bomb could be carried on the fuselage centreline between the spars and another 1,000lb (454kg) bomb (or a drop tank) could go under each of the inner wings. Internal fuel totalled 300gal (1,364lit) but the drop tanks increased capacity to 520gal (2,364lit) and allowed the aeroplane to act as a long-range fighter.

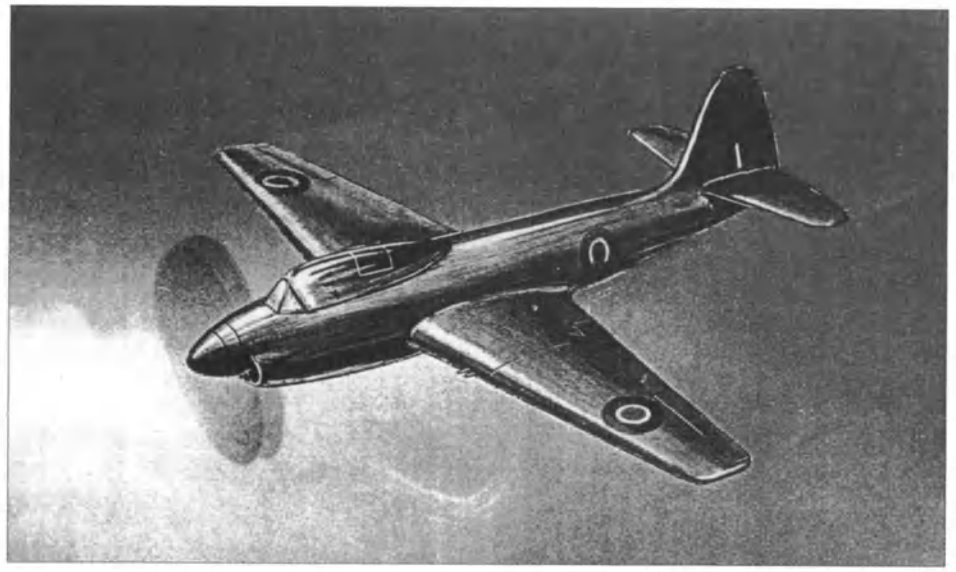
The torpedo cut the top speed at 20,000ft (6,096m) from 460mph (740km/h) to 388mph (624km/h) and increased time to 10,000ft (3,048m) from 4.1 minutes to 6.85 minutes; service ceiling for the short-range fighter condition was 36,000ft (10,973m) which fell to 29,600ft (9,022m) with the torpedo. The long-range fighter had range of 820 miles (1,319km). Equivalent figures for the Griffon were 397mph (639km/h) at 20,000ft down from 473mph (761km/h), 4.25 and 7.0 minutes, 38,000ft (11,582m) and 31,750ft (9,677m), and 860 miles (1,383km). The twin-Merlin Project A, the main proposal, did not compare at all well with the concurrent Westland N.11/44 (later the Wyvern). Although Fairey's design was expected to have the better take-off and climb performance in other respects it fell short of the N.11/44 and the naval staff's requirements.

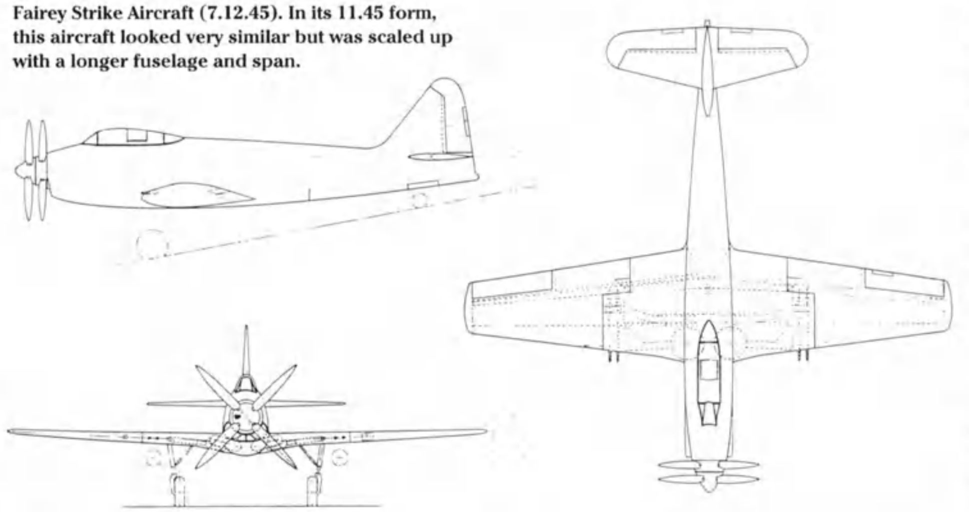
During March 1945 Fairey revised and improved the design which, although still schemed around two Merlin RM.17.SMs and carrying additional internal fuel, was made more compact. In revised form some Ministry staff thought the project was quite promising and at last compared reasonably well with the Westland. It was better in climb and as good in speed as the N.11/44 up to 20,000ft (6,096m), but above this the Westland pulled away and had a considerable advantage in speed. However the Merlin had practically reached its design peak and it was becoming increasingly obvious that the piston would inevitably be superseded by the gas turbine. N E Rowe observed that this aircraft was more suited to a turbine propeller and so, after a request from the Ministry, Fairey also investigated using a Rolls-Royce Clyde or other jet-cum-propeller gas turbine engines (that is, turboprops) as an alternative. However, it was found that these did not offer such a good performance as two Merlins.

Next Rolls-Royce provided advance data for three different sizes of turboprop, referred to as the RB.52 (an improved Clyde), RB.52 + 30% and RB.52 + 50%. These were also investigated as alternatives for the strike fighter but the twin Merlins still gave better results and Fairey concluded that the high cruising consumption of the single turbine engine running in a throttled condition was mainly responsible for the poor comparison. The company suggested that the use of small twin turbines driving contra-rotating propellers, in a manner similar to the tandem piston scheme, would show much better results than a single turbine of the same aggregate power; one of the small turbines alone would be used for cruising. Fairey now prepared two new naval strike fighter studies, one having a single RB.52 + 50% turboprop with contra-rotating propellers, the other two 75% RB.52s arranged in tandem with a separate contra-propeller gearbox, each propeller being driven by its own turbine.

A summary of these projects, plus a twin piston scheme for comparison, was submitted to MAP on 30th June 1945, each having a span of 52ft (15.8m), four 20mm cannon and a torpedo. The pistons offered a total of 3,920bhp (2,923kW), gave an all-up-weight of 23,900lb (10,841kg), maximum speed 410mph (660km/h) at 10,000ft (3,048m) and

Impression of the Fairey Strike Aircraft at 11.45.





Fairey Strike Aircraft (7.12.45). In its 11.45 form, this aircraft looked very similar but was scaled up with a longer fuselage and span.

6.8 minutes to 10,000ft; the RB.52 + 50% 3,525bhp (2,629kW) and 1,090lb (4.8kN) thrust, 24,400lb (11,068kg) weight, 395mph (636km/h) at 10,000ft and 2.67 minutes to that height; the two 75% RB.52s the same power, 23,300lb (10,569kg), 413mph (665km/h) and 2.50 minutes. The twin turbine saved 1,100lb (499kg) in weight, cut down the frontal area and increased the speed over the single turbine alternative, and it also offered a performance that was better in some respects that the twin Merlin.

A Ministry report suggested that a single Clyde was, generally speaking, inferior to the twin Merlin on all counts of performance but the higher-power engines gave an aircraft which was much more attractive and became a strong competitor to the N.11/44. In mid-June the Admiralty approved in principle the Fairey strike fighter as a type that it would like to encourage and during September the company made considerable progress with the turbine versions of the aircraft. In due course Staff requirements were raised for an O.5/43 (Spearfish torpedo bomber) replacement based around Fairey's project; this became Specification N.16/45 but no prototypes were ordered until 20th June 1946.

At the end of the war it became necessary for the Ministry to review a large number of engine projects and Rolls-Royce was requested to state its views as to whether the twin-tandem piston engine designs should be continued or abandoned in favour of the turboprop. At a meeting held at MAP Rolls stated that it was entirely in favour of using Fairey's twin-turboprop arrangement for the naval strike project and undertook to produce the special engine and gears. It was here that the decision to abandon the four O.21/44 torpedo bomber prototypes (Chapter 9) was taken while the naval strike project was now reconsidered around the twin turboprop arrangement. Strike had become the primary role for Fairey's aircraft – whereas Westland's Wyvern was essentially designed as a fighter but with provision to carry offensive weapons the Fairey had become a strike aircraft which, after releasing its load, was expected to be capable of offensive combat against all of the enemy aircraft it was likely to meet. Rolls-Royce also stated that, for this particular purpose, its policy now was to develop axial flow jet engines and so Fairey abandoned its tandem arrangement in favour of putting the two engines side-by-side behind the main gearbox and beneath the floor of the pilot's cockpit.

A draft of the layout was shown to Rolls-Royce, who were entirely in favour, and it was adopted as the latest scheme for the naval strike aircraft; the engine itself was now called the AP.25. A full brochure was submitted to Rowe, now DGTD, on 13th November and noted that, although the AP.25 was still only a paper engine, Rolls-Royce had undertaken to provide a powerplant ready for installation by December 1946. Fairey had become quite frustrated by so many changes to its naval aircraft programmes and Hollis-Williams stated in his covering letter that 'this investigation has hung about now for 18 months, and probably constitutes a record in time wastage for the start of a new design, but it has been influenced very largely by the changeover from reciprocating engines to turbines and we have to admit that the design has steadily improved with each successive effort'.

The turbine engine favoured FAA aeroplanes very much because so much power was available for take-off, which made the 'take-off problem' no longer a criterion of the design. This meant Fairey had had to revise its ideas on flap systems and the new study abandoned the Youngman type flap, whose chief virtue was a very efficient take-off setting, and adopted a new design based on Fowler principles. As a result it also had a completely clean trailing edge without hinge brackets, which had been a feature of Fairey's recent designs. The all-metal structure was built on normal lines but improvements had been introduced to the wing structure to simplify the production problem of producing the high finish necessary to maintain laminar flow. The torpedo was still carried on the fuselage centreline but bombs, depth charges or rockets would be carried under the wing outboard of the undercarriage between and below the cannon.

The two side-by-side power units each drove its own propeller through an independent gear train carried by a common centrally disposed gearbox. The two jet pipes ejected through the bottom of the fuselage just behind the wings and were disposed in such a manner that, in the event of one engine and propeller being stopped, any loss of aircraft stability resulting from the consequent introduction of torque reaction and single propeller slipstream effects would be wholly or partly balanced by an equal and opposite loss of thrust from the relevant outlet pipe. Internal fuel for the torpedo role was 545gal (2,478lit) but 595gal (2,705lit) could be carried for fighter escort work; these versions' respective times to 10,000ft (3,048m) were 2.1 and 1.9 minutes and service ceilings 44,000ft (13,411m) and 49,000ft (14,935m). The type could also be adapted as a two-seat night fighter and for photo reconnaissance work.

On 21st November R S Sorley noted that the subtle proposal to balance torque reaction when only one propeller was in action was a selling point on which it would be difficult to produce data. Rowe then advised Fairey that there was ample reserve on the take-off specification and cruising range to allow the wing area and overall size to be reduced and on 10th December Fairey completed an amended design to the draft N.16/45, whose functions had now also been altered (all reference to the fighter and reconnaissance roles was gone and dive bombing had been introduced). Folded span was 20ft (6.1m), as previously, and a generous tail volume was provided to give a desirable standard of stability. Time to 10,000ft (3,048m) was now 2.25 minutes and service ceiling 38,500ft (11,735m), range 700 miles (1,126km).

On 2nd January 1946 the Admiralty announced that it wished to go ahead with the project as rapidly as possible, with a target date for first flight 18 months from the date of the Advisory Design Conference; however, it became apparent that the coupled powerplant was not expected to be available until early 1949. On 14th August the idea of leaving out the gun to save weight was considered, which gave a maximum speed clean of 476mph (765km/h), and on 18th September Fairey was asked to study a tricycle undercarriage. On 7th October the project was described as becoming too heavy for naval requirements and two days later, at the Design Conference, Fairey was asked to take out 1,000lb (454kg) of weight. On that day a target date was also discussed for the Fairey GR.17/45 project (later to become the Gannet) and it was agreed to give this aircraft definite priority over the N.16/45.

By 20th January 1947 the powerplant had been named the 'Coupled Tweed' and each unit gave 3,020shp (2,252kW) and 380lb (1.7kN) thrust. On 12th March the Admiralty no longer felt that the aircraft was promising enough to warrant the expenditure of the money and effort that would be involved and so made it clear that it desired not to continue with the project. Cancellation of the N.16/45 would, from the Admiralty's point of view, also make it agreeable to abandon work on the AP.25 as well. Fairey had put a considerable amount of work into this aircraft, while also being in competition with Westland with its Wyvern studies, but Rolls-Royce eventually fell into programme difficulties and was forced to cut out a vast amount of development work. The twin-coupled AP.25 was one of the developments cancelled and, since there was no other powerplant which could be conveniently installed in Fairey's design, it was agreed that further work on the N.16/45 should also be discontinued. The Wyvern, however, was continued.

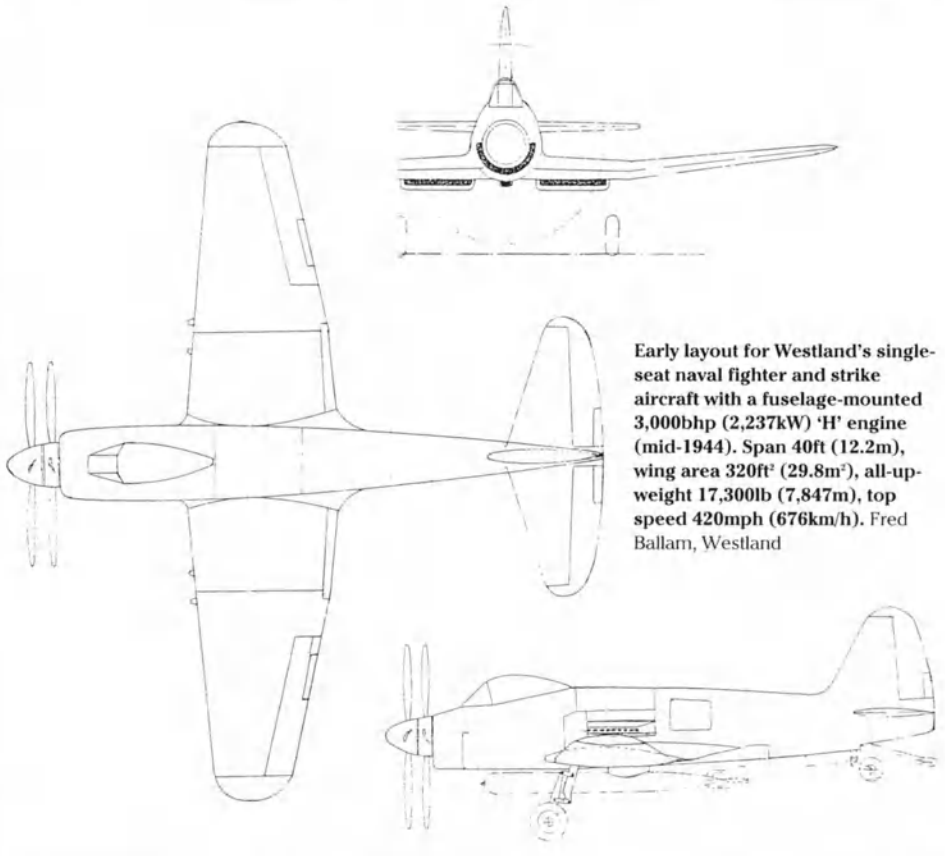
Fairey itself carried on with the Gannet and that story is taken up by *British Secret Projects Volume 2: Jet Bombers since 1949*. The early 'Gannet' layouts were quite similar to the N.16/45 because Fairey's Design Office made use of the experience it had gained with the older project to save time.

Westland Wyvern

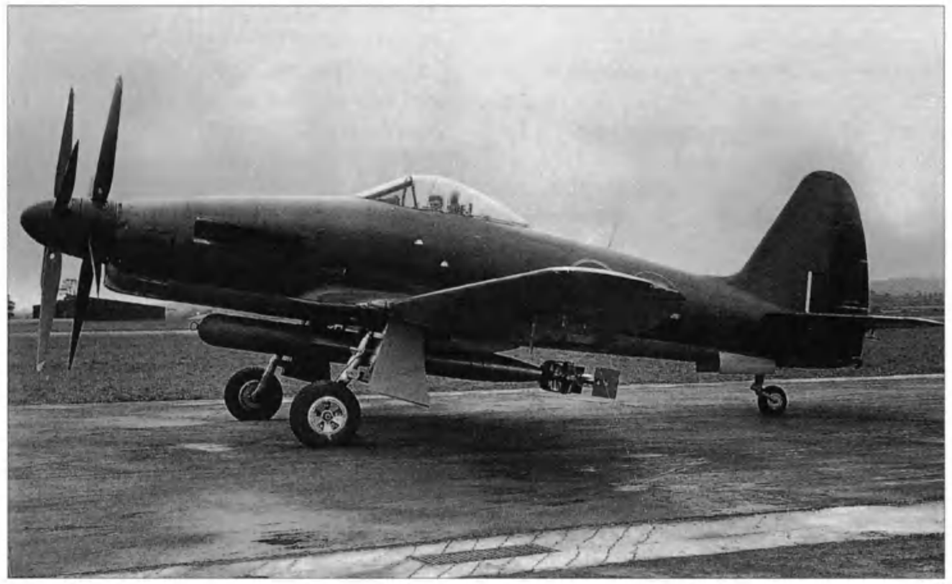
Chapter 12 will explain how W E W Petter, Westland's technical director, completed his initial studies for a high-speed twin jet-powered fighter bomber in early 1944. At roughly the same time, or just afterwards, he also proposed a single-seat fleet fighter powered by Rolls-Royce's new and large 'H' reciprocating engine (later to be called the Eagle). In April the initial work was expanded to embrace three versions of the design, one with a shaft drive 'H', one with a nose-mounted 'H' and one with a nose 'turbine airscrew' (turboprop); each was offered as a naval or RAF fighter. A MAP meeting held on 19th April agreed that a long-range fighter striker for RAF and naval use should be of outstanding use and it was also agreed that Westland should proceed with its design (presumably with the nose-mounted 'H' engine, as built).

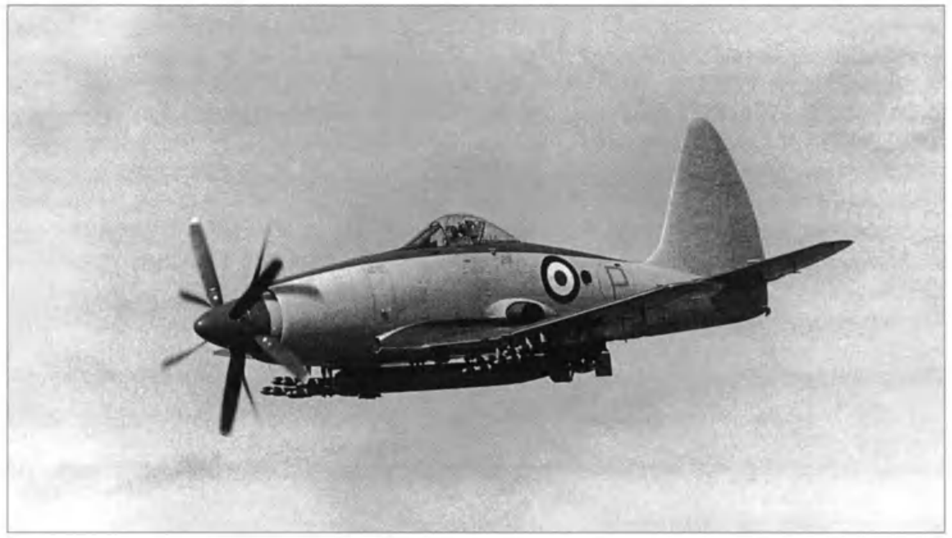
On 23rd June Petter tendered the basic aircraft under the designation W.34, powered by the 'H' engine with an initial output of 3,230hp (2,409kW) at 23,000ft (7,010m) – the target output was 4,500hp (3,356kW). Span was 44ft (13.4m) and wing area 350ft^2 (32.6m^2). For short-range operations 230gal (1,046lit) of fuel were carried and for torpedo work 430gal (1,955lit). Gun armament was four 20mm cannon (reduced to two when carrying a torpedo) and the following data was given for short-range fleet fighter, torpedo bomber and RAF short-range fighter – take-off weight 17,355lb (7,872kg), 20,420lb (9,263kg) and 16,735lb (7,591kg), maximum speed at 25,000ft (7,620m) 472mph (759km/h), 432mph (695km/h) and 480mph (772km/h), and rate of climb at 5,000ft (1,524m) 3,970ft/min (1,210m/min), 2,860ft/min (872m/min) and 4,150ft/min (1,265m/min). As a fighter service ceiling was 39,000ft (11,887m).

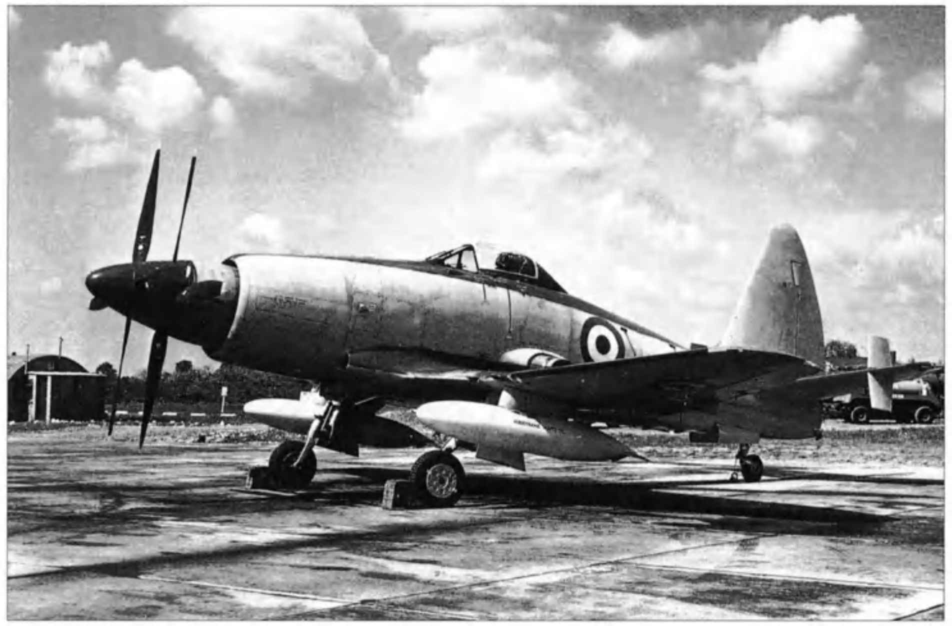
By early July the Admiralty was showing a keen interest in the aircraft. However AVM J D Breakey, ACAS(TR), told CRD that he felt that the estimated performance was disappointing. The top speed, given as 480mph (772km/h) by Westland and re-estimated at 463mph (745km/h) by Liptrot, was less than that expected from the F.2/43 and Hornet, both of which would be in service some 2-3 years earlier. Its ceiling and rate of climb were inferior and range no greater except in the one condition when carrying 2,000lb (907kg) of bombs. Breakey declared that this last feature 'is virtually the aircraft's only merit and seems a very small return for the large step up in power given by the 'H' engine, and an increase in weight of some 6,000lb (2,722kg) over the F.2/43. While we are, of course, decidedly interested in any new fighter project built around the 'H' engine, and particularly in one designed for further development using a turbine driven propeller, I feel in would be wrong to encourage Westland in believing that there is likely to be any considerable RAF use for this aeroplane. I should have much preferred to see this firm tackling a straightforward fighter of the F.2/43 type but built around the 'H' and capable of



Early layout for Westland's single-seat naval fighter and strike aircraft with a fuselage-mounted 3,000bhp (2,237kW) 'H' engine (mid-1944). Span 40ft (12.2m), wing area 320ft^2 (29.8m^2), all-up-weight 17,300lb (7,847m), top speed 420mph (676km/h). Fred Ballam, Westland







This is TS380, the fourth prototype Rolls-Royce Eagle-powered Westland Wyvern. Fred Ballam, Westland

One of the Armstrong Siddeley Python-powered prototype Wyverns displays a full load of torpedo and rockets. This is probably VW867 at the 1951 Farnborough Show.

A 'VZ' serial Wyvern S Mk.4 seen at Merryfield in 1953. Note the additional tail finlets.

development with the turbine-cum-propeller. I realise that such an aircraft must be heavier than the F.2/43 but I am quite sure that it need not go up to 16,000lb (7,258kg).'

Nevertheless the Admiralty went ahead. Specification N.11/44 was written around the type and in August 1944 six prototypes were ordered; F.13/44 was also written to cover an RAF version but this was soon dropped. In fact the W.34 was designed from the start with the installation in mind, at a later stage as suggested by the first brochure, of the Rolls-Royce RB.39 Clyde turboprop. The Clyde version (called the W.35) had wings, tail, fin and empennage which were common to the W.34 but an all-new fuselage. In 1945 a new specification, N.12/45, was produced for this version and three prototypes were eventually ordered in February 1946.

Rolls-Royce intimated that it had insufficient facilities to permit the Eagle (as the 'H' had become) and Clyde to be developed concurrently and it was essential to concentrate effort on just one of these engines. Rolls' E W Hives explained that the Eagle in its present form could only be regarded as an interim version and two years work would be required to develop the engine fully (to 4,000hp [2,983kW]). In the case of Westland's aircraft it appeared that progressive improvements in performance were much more likely to accrue from development of the Clyde than from the Eagle. Rolls-Royce felt that energy should now be concentrated more on turbine engines and, as a result, the turboprop became the more important power unit for Westland's strike fighter.

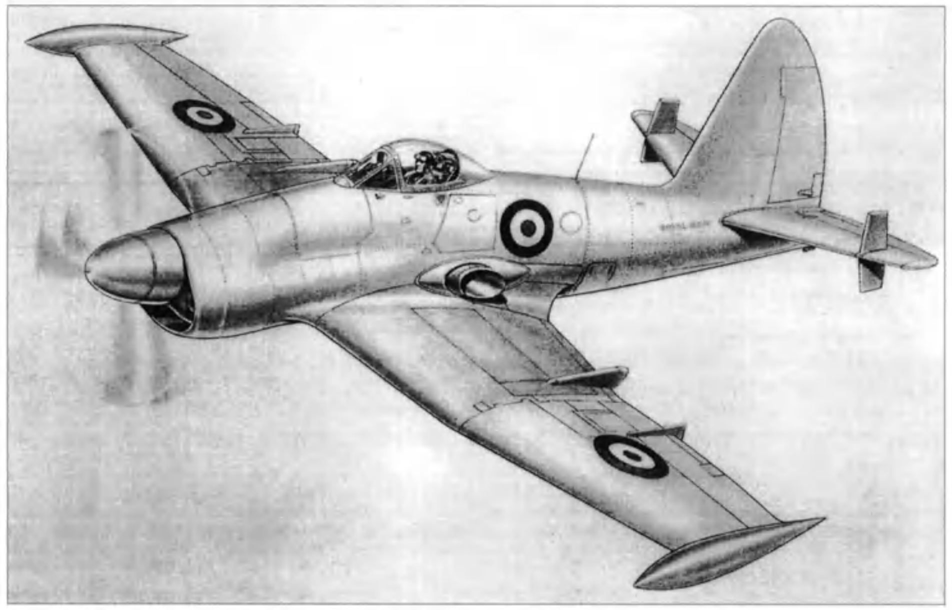
In June 1945 RAE reported that the original piston W.34 had been handicapped by the choice of an undeveloped engine of high specific weight and, for a high-speed aircraft designed to carry a large load in fuel and weapons, this had led to a high all-up-weight (in fact an extremely heavy aircraft) and, to keep down drag, a high wing loading. The chief effect of substituting the light Clyde for the heavy Eagle was a lower all-up-weight and wing loading. The take-off and landing performance of the Eagle version was poor but RAE stated that the Clyde would improve this and also provide a 50mph (80km/h) gain in speed and 1,000ft (305m) gain in climb at sea level, although the top speed at 20,000ft (6,096m) was unchanged. The performance at 20,000ft (445mph [716km/h] and 2,500ft/min [762m/min]) was not thought to be particularly good for a fighter which would not be in service for two years, but its combat range (550nm [1,019km] radius) was excellent for such a type. At this stage the Clyde was expected to give 2,300bhp (1,715kW) and 1,040lb (4.6kN) thrust at sea level.

By now Petter had left Westland for English Electric and had been succeeded by John Digby as chief designer and Arthur Davenport as technical director. On 27th June 1945 Davenport was able to supply some extra data. The Eagle fighter would now have an all-up-weight of 19,194lb (8,706kg) and the torpedo striker 21,879lb (9,924kg) while the W.35 Clyde would give respective weights of 16,300lb (7,394kg) and 19,045lb (8,639kg). By early June 1945 four Eagles had been running for around six months during which a redesign of the crankcase had already been completed.

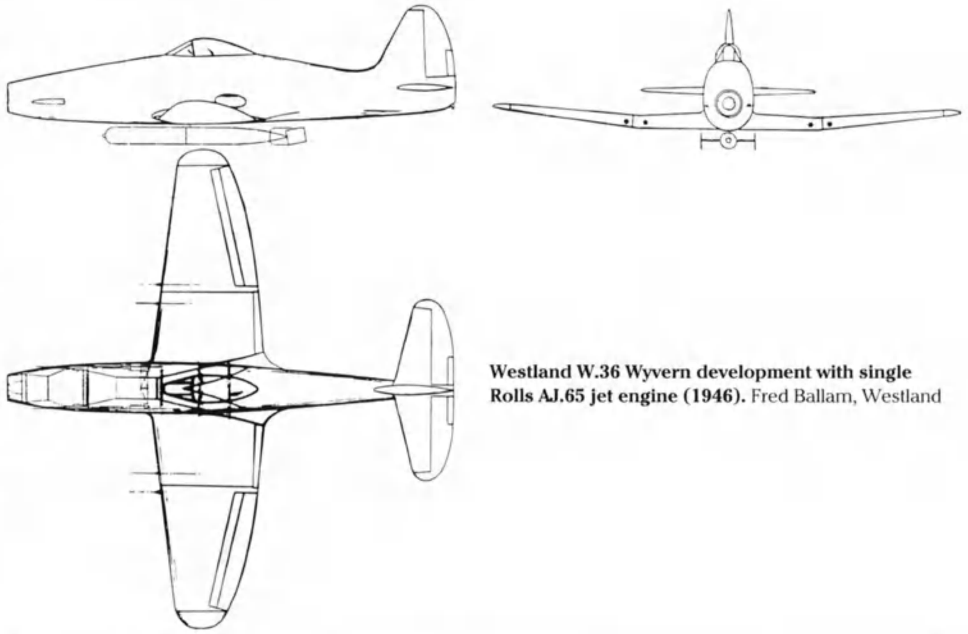
During the first half of 1946 the Armstrong Siddeley Python turboprop entered the picture. On 7th February it was agreed that this engine was a very satisfactory alternative and there were good reasons for installing it in the fifth and sixth N.11/44s. However, by May the prototype and pre-production programme comprised six Eagle N.11/44s to fly between September 1946 and February 1947, twenty pre-production N.11/44s to follow them, two Python-powered N.12/45s to fly in August and September 1947 and three Clyde N.12/45s to fly between December 1947 and February 1948. Soon afterwards however, in the interests of economy, it was agreed to call for one Python instead of the Clyde in one of the three Clyde machines and to order only one further Python prototype.

In June 1946 Westland also began to examine a variant fitted with an Armstrong Siddeley Cobra powerplant (a new low-power jet) which would need a smaller jet pipe. Although three and a half years away, the Cobra was seen as another suitable alternative to the Clyde and little difficulty was expected in fitting it. However, a report dated 14th January 1947 confirmed that, although the study had been completed, the design was not proceeded with; it was also subsequently agreed that the Cobra engine would not be produced. In the event all six Eagle-powered W.34 prototypes were built and flown, the first TS371 becoming airborne on 12th December 1946, but only three turboprop W.35 prototypes were completed. VP109 (flown 22nd March 1949) and VP113 received Pythons while VP120 (flown 18th January 1949) was to be the only aircraft anywhere to be powered by a Clyde; the development of this engine was abandoned. The fourth W.35 prototype was cancelled and the name Wyvern was not applied until early 1947.

There were long delays getting the Wyvern into service with many development problems. Of the twenty pre-production Eagle W.34s, just the first four were delivered and only ten were built, however 96 production examples of the turboprop W.35 were to be completed. The first Wyvern squadron received its aircraft in 1954 but the type only stayed in front line service for four years. The ultimate version was the S Mk.4, the torpedo fighter TF designation being dropped for strike after the Sea Fury filled its fighter role. However, an S Mk.5E was proposed in March 1954 fitted with a Napier E.141 Double Eland turboprop in a new cowling and fitted with wingtip tanks, but it was not built. Finally, in 1946 a version called the W.36 was drawn with a Rolls-Royce AJ-65 or MetroVick F.9 axial jet engine.



Artist's impression of the Wyvern S Mk.5E (3.54). Fred Ballam, Westland



Westland W.36 Wyvern development with single Rolls AJ.65 jet engine (1946). Fred Ballam, Westland

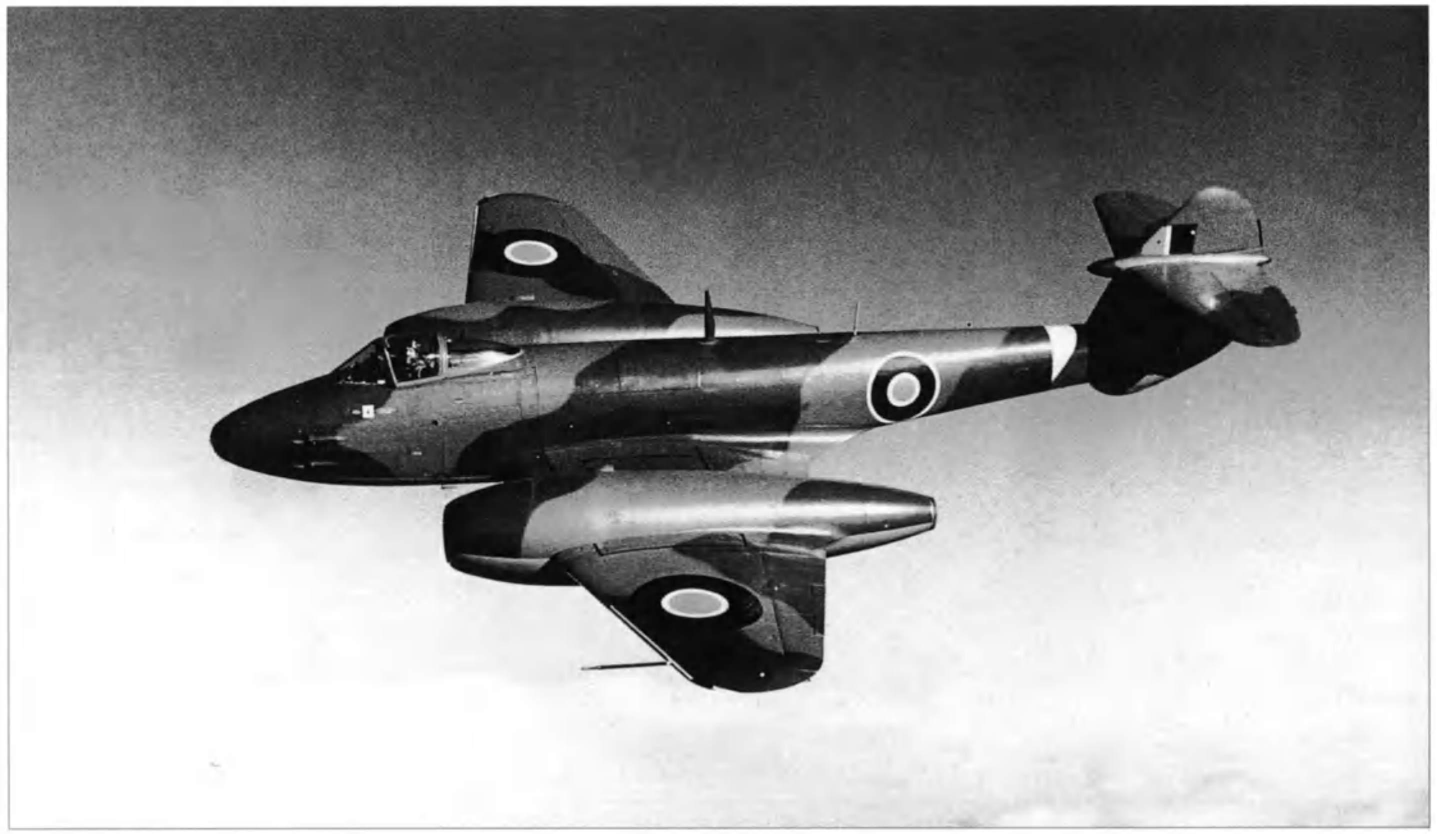
Naval Fighters – Estimated Data

Project	*Span ft in (m)*	*Length ft in (m)*	*Gross Wing Area ft² (m²)*	*Max Weight lb (kg)*	*Engine hp (kW)*	*Max Speed / Height mph (km/h) / ft (m)*	*Armament*
Fairey Fulmar Mk.I (flown)	46 4.5 (14.1)	40 3 (12.3)	342 (31.8)	9,800 (4,445)	1 x Merlin VIII 1,080 (805)	280 (451)	8 x 0.303in (7.7mm) mgs
Specification N.8/39							
Blackburn N.8/39	49 0 (14.9)	39 8 (12.1)	356 (33.1)	10,080 (4,572)	1 x Hercules HE.6.SM	313 (504) at 15,000 (4,572)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Fairey N.8/39	48 0 (14.6)	39 3 (12.0)	340 (31.6)	9,422 (4,274), 10,627 (4,820), 9,827 (4,458) or 9,207 (4,176)	1 x Boreas, Griffon, Queen or Taurus	Griffon 319 (513) at 15,000 (4,572)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Gloster N.8/39	50 0 (15.2)	39 4 (12.0)	396 (36.8)	9,929 (4,504)	1 x Hercules HE.6.SM	330 (531) at 17,000 (5,182)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Gloster N.8/39	47 6 (14.5)	39 0 (11.9)	374 (34.8)	9,462 (4,292)	1 x E.112	?	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Hawker N.8/39	50 0 (15.2)	39 6 (12.0)	365 (33.9)	9,720 (4,409)	1 x E.112	?	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Supermarine 333	44 0 (13.4)	34 0 (10.4)	320 (29.8)	8,745 (3,967)	1 x Merlin RM.2.SM 1,225 (913)	342 (550) at 18,750 (5,715)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Supermarine 333	46 0 (14.0)	36 0 (11.0)	360 (33.5)	9,630 (4,368)	1 x Griffon RG.1.SM 1,560 (1,163)	375 (603) at 17,500 (5,334)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Specification 'NAD.925/39'							
Blackburn 'single seat'	40 0 (12.2)	31 9 (9.7)	236 (21.9)	8,881 (4,028)	1 x Griffon	381 (613) at 15,000 (4,572)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Fairey	42 0 (12.8)	34 3 (10.4) (tail down)	292 (27.2)	9,232 (4,188) mgs only, 9,380 (4,255) cannon, 9,850 (4,468) 2 seat + cannon	1 x Griffon RG.1.SM 1,600 (1,193)	382 (615) at 15,000 (4,572)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Fairey	44 0 (13.4)	35 10 (10.9)	335 (31.2)	10,732 (4,868) mgs only, 10,880 (4,935) cannon, 11,350 (5,148) 2 seat + cannon	1 x Sabre 2,500 (1,864)	411 (661) at 15,000 (4,572)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Gloster	40 0 (12.2)	33 7 (10.2)	283 (26.3)	9,102 (4,129)	1 x Griffon	368 (592) at 15,000 (4,572)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Hawker	42 0 (12.8)	32 1 (9.8)	277 (25.8)	8,750 (3,969)	1 x Griffon	363 (584) at 15,000 (4,572)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Supermarine	36 10 (11.2)	30 7 (9.3)	242 (22.5)	8,100 (3,674)	1 x Griffon	396 (637) at 15,000 (4,572)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Supermarine	39 0 (11.9)	31 3 (9.5)	282 (26.2)	9,205 (4,175)	1 x Sabre	428 (689) at 15,000 (4,572)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Westland	45 0 (13.7)	?	254 (23.6)	9,600 (4,355)	1 x Griffon 1,600 (1,193)	359 (578) at 15,000 (4,572)	8 x 0.303in (7.7mm) mgs or 4 x 20mm cannon
Fairey Firefly F Mk.I (flown)	44 6 (13.6)	37 7 (11.5)	328 (30.5)	14,020 (6,359)	1 x Griffon IIB 1,720 (1,283)	316 (508) at 14,000 (4,267)	2 x 1,000lb (454kg) bombs or 8 RP, 4 x 20mm cannon
Blackburn B.37 Firebrand Mk.I (flown)	50 0 (15.2)	38 2 (11.6)	381.5 (35.5)	13,643 (6,188), 15,557 (7,057) w bombs	1 x Sabre III 2,305 (1,719)	358 (576) at 17,000 (5,182)	2 x 500lb (227kg) bombs, 4 x 20mm cannon
Blackburn B.45 Firebrand Mk.IV (flown)	51 3.5 (15.6)	38 9 (11.8)	381.5 (35.5)	15,671 (7,108)	1 x Centaurus IX 2,520 (1,879)	350 (563) at 13,000 (3,962) clean	1 x 1,790lb (812kg) torpedo, 2 x 1,000lb (454kg) bombs or RPs, 4 x 20mm cannon
Hawker P.1009	50 0 (15.2)	35 8.5 ()	354 (32.9)	?	1 x Sabre	?	4 x 20mm cannon
Specification N.7/43							
Boulton Paul P.103A	38 8 (11.8)	36 4 (11.1)	250 (23.3)	10,221 (4,636)	1 x Griffon RG.5.SM	462 (743) at 28,000 (8,534)	4 x 20mm cannon
Boulton Paul P.103B	38 8 (11.8)	37 0 (11.3)	260 (24.2)	11,180 (5,071)	1 x Centaurus CE.12.SM	435 (700) at 23,000 (7,010)	4 x 20mm cannon
Fairey N.7/43 (dual powerplant 10.5.43)	44 0 (13.4)	37 0 (11.3)	301 (28.0)	12,670 (5,747)	1 x Peregrine 850 (634) plus 1 x jet 3,000lb (13.3)	492 (792) at 30,000 (9,144)	4 x 20mm cannon
Fairey N.7/43 (design C)	40 0 (12.2)	35 9 (10.9)	?	?	1 x Griffon 61 2,100 (1,566)	?	4 x 20mm cannon
Fairey N.7/43 (dual powerplant 7.6.43)	45 3 (13.8)	36 4 (11.1)	313 (29.1)	14,880 (6,750)	1 x Merlin 1,620 (1,208) plus 1 x jet 3,000 (13.3)	490 (788) at 30,000 (9,144)	4 x 20mm cannon
Westland N.7/43	44 0 (13.4)	?	275 (25.6)	11,340 (5,144)	1 x Griffon 1,650 (1,230)	385 (619) at 25,000 (7,620)	4 x 20mm cannon
Westland J.15 variant	40 0 (12.2)	?	285 (26.5)	11,000 (4,990)	1 x Halford H.1 3,000 (13.3)	390 (628) at sea level	4 x 20mm cannon
Hawker Sea Fury Mk.X	38 4 (11.7)	34 7 (10.5)	280 (26.0)	9,070 (4,114)	1 x Centaurus XVIII 2,480 (1,849)	465 (748) at 18,000 (5,486)	4 x 20mm cannon
de Havilland Sea Hornet F Mk.20 (flown)	45 0 (13.7)	36 8 (11.2)	361 (33.6)	c20,000 (9,117)	2 x Merlin 130 series 2,070 (1,544)	c465 (748) at height	2 x 1,000lb (454kg) bombs or 8 x RPs, 4 x 20mm cannon
de Havilland Sea Hornet NF Mk.21 (flown)	45 0 (13.7)	36 8 (11.2)	361 (33.6)	?	2 x Merlin 130 series 2,070 (1,544)	c461 (742) at height	2 x 1,000lb (454kg) bombs or 8 x RPs, 4 x 20mm cannon
Short 'Jet Sturgeon'	61 11 (18.9)	46 6 (14.2)	590 (54.9)	23,500 (10,660)	2 x AJ.40	?	4 x 20mm cannon
Boulton Paul P.105	38 0 (11.6)	34 5 (10.5) tail down	250 (23.3)	12,285 (5,572) torpedo 12,509 (5,674) bomber	1 x Centaurus CE.12.SM	469 (755) at 20,000 (6,096) at 12,500lb (5,670kg) as fighter	1 x torpedo or 2 x 1,000lb (454kg) bombs, 2 or 4 x 0.5in (12.7mm) mgs or 4 x 20mm cannon (fighter)
Boulton Paul P.107	38 0 (11.6)	34 8 (10.6) tail down	250 (23.3)	15,900 (7,212)	1 x Centaurus CE.12.SM	470 (756) at 22,000 (6,706)	4 x 20mm cannon plus 2 x mg
Blackburn B.48 Firecrest (flown)	44 11.5 (13.7)	39 3.5 (12.0)	361.5 (33.6)	16,800 (7,620)	1 x Centaurus 59 2,825 (2,107)	380 (612) at 19,000 (5,791)	1 x 2,097lb (951kg) torpedo, 2 x 500lb (227kg) bombs or 8 x RP, 2 x 0.5in (12.7mm) mgs (none carried)
Fairey Strike Fighter (Project A) (3.10.44)	49 0 (14.9)	40 4 (12.3)	415 (38.6)	17,900 (8,119) naval fighter 21,935 (9,950) torpedo strike	2 x Merlin RM.14.SM 4,400 (3,281) total	474 (763) at 23,000 (7,010)	1 x torpedo or 1 x 2,000lb (907kg) or 1,600lb (726kg) bomb, 2 x 1,000lb (454kg) bombs, 4 x 20mm cannon
Fairey Strike Fighter (Project B) (3.10.44)	52 4 (16.0)	42 9 (13.0)	475 (44.2)	21,100 (9,571) naval fighter 25,555 (11,592) torpedo strike	2 x Griffon RG.25.SM 5,250 (3,915) total	480 (772) at 23,000 (7,010)	1 x torpedo or 1 x 2,000lb (907kg) or 1,600lb (726kg) bomb, 2 x 1,000lb (454kg) bombs, 4 x 20mm cannon
Fairey Strike Fighter (13.11.45)	51 0 (15.5)	44 7 (13.6)	390 (36.3)	23,100 (10,478) torepdo fighter 23,100 (10,478) escort fighter	2 x AP.25 2,517 (1,877) plus 1,015 (4.5) each	435 (700) at 6,000 (1,829) torp 494 (795) at 9,500 (2,896) escort	1 x torpedo, 2 x 1,000lb (454kg) or 500lb (227kg) bombs, depth charges or 6 x RP, 4 x 20mm cannon
Fairey Strike Aircraft (10.12.45)	46 0 (14.0)	44 7 (13.6)	370 (34.4)	23,000 (10,433), 21,100 (9,571) no bombs	2 x AP.25 2,517 (1,877) plus 1,015 (4.5) each	443 (713) 497 (800) clean at 10,000 (3,048)	Bombs, plus torpedoes
Westland Wyvern TF Mk.1 (flown)	44 0 (13.4)	39 3 (12.0)	355 (33.0)	21,879 (9,924) torpedo 19,194 (8,706) clean	1 x Eagle 22 3,560 (2,655)	456 (734) at 23,000 (7,010)	1 x 20in (51cm) torpedo or 1,000lb bomb under fuselage, 2 x 1,000lb bombs or 8 x RP under wings, 4 x 20mm cannon
Westland Wyvern S Mk.4 (flown)	44 0 (13.4)	42 3 (12.9)	355 (33.0)	21,200 (9,616) norm	1 x Python 3 3,670 (2,737) plus 1,180 (5.2)	388 (624) at sea level	1 x 2,500lb (1,134kg) torpedo or 1,000lb bomb under fuselage, 2 x 1,000lb bombs or 16 x RP under wings, 4 x 20mm cannon

Supermarine Seafire with wings folded.

Chapter Eleven

Jet Fighters



Gloster Meteor F Mk.4.

The development of the jet engine was to revolutionise the design of both military and civilian aircraft but it was to be the former, and particularly the fighter, which benefited first. Frank Whittle's achievement in developing the jet is well known but the task of producing the first aircraft designed to use his engines, principally work by the Gloster Aircraft Company, is not so well documented. By the end of the war Gloster had completed a series of jet fighter designs while most of the industry's other 'fighter specialists' had also moved into the jet field.

Gloster E.28/39

Some Ministry papers refer to Britain's first jet aircraft as the 'Weaver' but in fact this was a security code name. Whittle first visited the Gloster works on 29th April 1939 where he spoke to Carter and test pilots Michael Daunt and Gerry Sayer. He had been introduced to Carter and Sayer before and told them 'as much as they could have found out from an examination of patent records'. He also gave Carter some idea of the nature of the jet engine and it was agreed that they should try to get the Air Ministry to make official contact with Gloster. During October it was realised that a specially designed aircraft was essential to test the jet engine because no existing aircraft could be modified to take this new power unit. Fortunately there was a lull in Gloster's design workload which, coupled with the good relationship that had grown between Whittle and Carter, ensured that the company did get a contract to build some prototypes.

During a meeting held at RAE Farnborough on 13th October Carter produced drawings of two alternative arrangements for prototype jet aircraft. The basic design was a mid-wing monoplane with the pilot forward of the wing and the engine installation immediately aft of the wing's main spar. One scheme had a normal fuselage with the propelling jet emerging behind the tail; the other had its tail surfaces supported by an extension boom following the lines of the pilot's head fairing which left the engine bay clear of all structural considerations. In the second case the engine installation was suitably faired into a short exhaust pipe.

The design of an airframe that would fully exploit the unique advantages of jet propulsion had been considered from the points of view of satisfying all strength and structural rigidity requirements together with good control and stability over the speed range. To achieve this, however, implied some limitation on the theoretical optimum performance obtainable from the engine; even so, Carter said the performance from every aspect was quite exceptional. One of the biggest problems was to provide a satisfactory method of introducing the air to the 'supercharger' (that is, the compressor). At sea level some 26lb (11.8kg), or $330ft^3$ ($9.3m^3$), of air per second was required by the engine and it was not considered desirable to exceed a velocity of 200ft/sec (61m/sec) in the air duct, so this required a pipe of about 18in (45.7cm) in diameter.

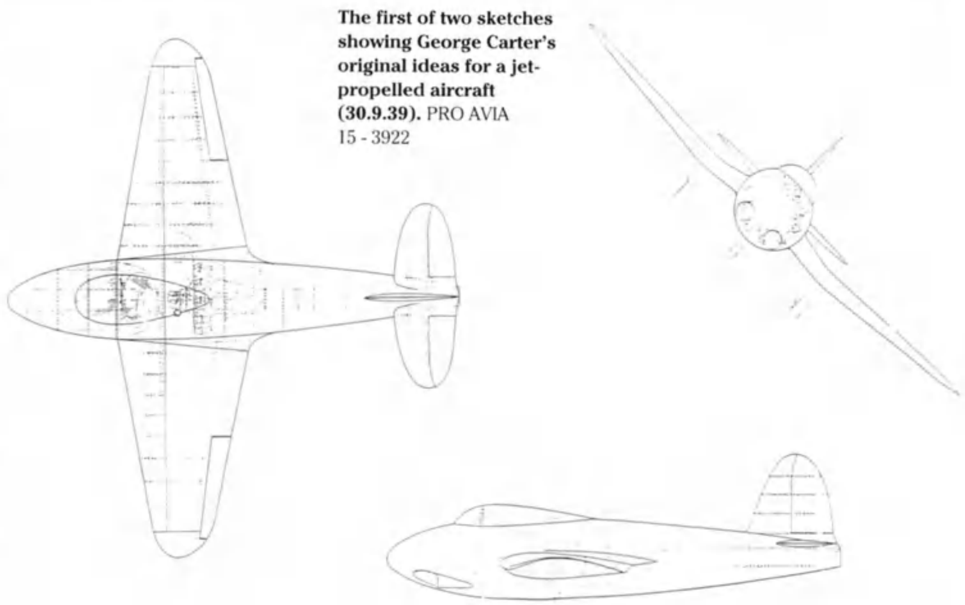
A simple form of tricycle undercarriage was adopted and in general the project showed great simplicity; the brochure also speculated on the military advantage of such a type and included possibilities for guns. Estimated top speed was 415mph (668km/h) at sea level, rate of climb at sea level 5,000ft/min (1,524m/min), time to 30,000ft 9.0 minutes, and ceiling 50,000ft (15,240m). The design embodied 12% wing thickness at the root tapering to 9% at the tip and it was suggested that the maximum thickness should be 0.4 of the chord. RAE's estimated top speed was 470mph (756km/h) at 30,000ft (9,144m) and it was decided to use a model to test the possible influence of the jet on the afterbody design. It was also agreed to recommend building two sets of wings, the second of which would be a special set for high speeds.

On 29th November 1939 a conference was held at the Harrogate Grand Hotel to discuss a covering specification. This was chaired by H Grinstead and included among others R W Walker and G L James from Gloster, Perring from RAE Aero Department, R N Liptrot and Frank Whittle. Gloster now estimated the weight to be 3,130lb (1,420kg) and, based on a static thrust of 1,200lb (5.33kN), predicted that at sea level the maximum speed would be 401mph (645km/h) and rate of climb 4,440ft/min (1,353m/min). It was agreed to call for a speed at sea level of 380mph (611km/h) and rate of climb 4,000ft/min (1,219m/min) but it was still undecided whether to use a long or short jet pipe. The specification, E.28/39, was approved on 21st January 1940.

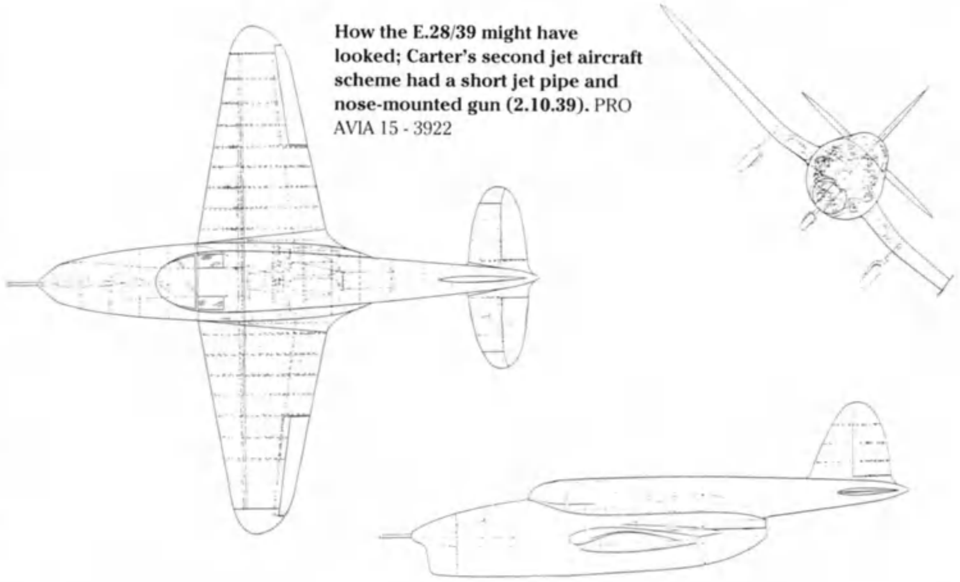
Earlier, on 4th January, Richard Walker had told Gloster Hucclecote's RTO that the 'short jet Scheme 2 design is considered an improvement over Scheme 1 as it overcomes the structural, accessibility and maintenance difficulties'. It was felt that the short jet pipe and fuselage would result in an increase of some 14mph (22.5km/h) in maximum speed, but as the jet efflux might give rise to unknown airflow conditions over the boom-mounted tailplane, the Scheme 1 method was ultimately adopted. The small split nose intakes on Scheme 1 were eventually replaced by the larger single orifice that appeared on the completed aircraft.

A contract to build two prototypes, W4041 and W4046, was placed on 3rd February 1940 and design work proceeded swiftly. The Mock-Up Conference was held on 22nd April and the initial construction work on the two E.28/39s was carried out in the Gloster Experimental Shop at Brockworth. However, the threat of large-scale bombing of aircraft factories sited on aerodromes meant that one of the airframes was moved to Regent Motors Garage in Cheltenham. Work continued in great secrecy and by 8th July the assembly of the fuselage frames was complete, metal covering was under way and the first set of wings was coming along well. The tail and fin were tunnel tested and cleared in January 1941 but there was much discussion on the steerable nosewheel unit. This was a new idea because the lack of a propeller meant that there would be no slipstream over the tail surfaces which would reduce the ability of the rudder to keep the undercarriage on a straight course during the take-off run.

On 24th March 1941 Cranwell was chosen as the venue for the first flight because it was desired to reduce the risk to the early flights by having aerodrome conditions as ideal as possible. It was intended to have a number of official visitors present for the first flight (at least thirty wished to attend) but, because of



The first of two sketches showing George Carter's original ideas for a jet-propelled aircraft (30.9.39). PRO AVIA 15 - 3922



How the E.28/39 might have looked; Carter's second jet aircraft scheme had a short jet pipe and nose-mounted gun (2.10.39). PRO AVIA 15 - 3922

The first Gloster E.28/39, W4041, seen before it received a camouflage colour scheme. The side fuselage band was made of temperature-sensitive paint to check the heat effects of the new method of jet propulsion on the fuselage structure. Eric Morgan

W4041 seen later in its career fitted with small auxiliary fins for extra directional stability. Eric Morgan

The first Gloster Meteor prototype DG206, shown here in 1944, was fitted with de Havilland H.1 engines which required fatter nacelles.

the intention to minimise the interference with other flying and the consequent need for the trip to take place during the early morning or in the evening, there was a need to accommodate them overnight. The number of visitors was not to exceed the amount of available accommodation and this generated quite a bit of correspondence. Those invited to attend were the Secretary of State, the Minister of Aircraft Production (Beaverbrook), Sir Henry Tizard, CAS, Mr Hennessey, DTD, DSR and others, but some had to drop out because the maiden flight was deferred by several days.

The famous first flight of a British jet aircraft took place on 15th May 1941 and W4041 achieved a maximum ASI of 240mph (386km/h) at 4,000ft (1,219m). Three more flights were made the following day when 280mph (451km/h) ASI was reached at 10,000ft (3,048m). On 20th May Tizard wrote 'In my opinion we have now reached a stage when the odds against the jet propulsion engine of the Whittle type being developed to a successful issue in the near future have disappeared.' Later, on 12th January 1942, he added that 'consideration must be given to the possible use of the experimental single-engine machine [the E.28/39] as a fighter'. However, it was ultimately decided that the two prototypes would be engaged in Whittle engine flight test work.

Gloster Meteor

The E.28/39, although nominally a fighter, was not equipped as such and the aircraft was only really intended to test the Whittle engine and to be used for experimental work in general. It was soon realised that a fighter design would have to be started from scratch. When considering aeroplanes powered by current turbine engines, a report from RAE's W G A Perring and Arnold Hall, dated 10th April 1940, confirmed that the following points had to be taken into account:

1. The efficiency of the engine improved with forward speed, so this type of propulsion was therefore best applied to designs in which a high forward speed was essential.
2. The jet turbine engine offered unique advantages in weight but at the cost of a rather heavy fuel consumption. This consumption decreased with increases in operating altitude, the actual consumption being roughly proportional to the local density of the air.
3. At a given altitude, the range of aircraft powered by jet turbine engines would be almost independent of the forward speed.
4. The maximum forward speed of such an aircraft would not be so greatly affected by altitude as that of a conventional (piston) aeroplane.

The conclusions drawn from these points were that if long range was required a jet-propelled aeroplane should be designed for high altitude, but it would need a pressure cabin. If an efficient cabin was produced and the engine was capable of operating over long distances at high speed, the construction of a high-altitude long-range bomber would then become possible. Finally, because of its high ground speed and high rate of climb, the jet-propelled aeroplane could be adapted to form an excellent interceptor fighter, although in this case it must be recognised that long range was impracticable since attempts to attain long range at low altitudes will involve fuel loads that will completely swamp the weight advantages possessed by the engine. Provided short range was accepted for fighter work, aircraft of this type should possess excellent characteristics for their roles.

From the viewpoint of aerodynamic efficiency and manoeuvrability, a single-engined type offered advantages over any multi-engined scheme. However, a military load of 1,500lb (680kg) minimum was needed for a fighter and the power ratings expected in the short term from current and new Whittle engines would make a single-engined type unsuitable for this duty. Attention therefore had to be given to the twin-engine arrangement with a total static thrust of some 3,200lb (14.2kN). Perring and Hall recommended that a twin-engined type of 8,500lb (3,856kg) all-up-weight should be undertaken immediately while the production of an aeroplane of 11,000lb (4,990kg) weight should be borne in mind to use the later Whittle W2 and alternative axial engines. Frequent reference was often made to Whittle's Gyrones, the code name for the Whittle engine. (Test flying eventually revealed that the maximum level speed performance of a jet aircraft was extremely sensitive to changes in air temperature – a 10° rise might cut the speed by 20mph [32km/h], for example from 405mph [652km/h] to 385mph [620km/h]).

By mid-May, following these initial RAE estimates for a jet fighter and more detailed investigation of them by George Carter, the aircraft was expected to weigh between 8,700lb and 9,000lb (3,946kg and 4,082kg) and carry 1,800lb (816kg) of military load. The armament would comprise two or four 20mm cannon plus six 0.303in (7.7mm) machine guns and the top speed would fall between 400mph and 431mph (644km/h and 693km/h) at sea level and 450mph to 470mph (724km/h to 756km/h) at 30,000ft (9,144m).

On 17th April W S Farren told Carter 'I feel there is a great deal to be said in its favour. If you could manage to include four 20mm combined with a certain amount of 0.303in, it would give us a far higher speed and operational height than any other aircraft we have in view, with an armament which would be fully able to deal with anything for which such a performance would be essential – namely the high speed lightly armed or unarmed bomber'. Farren saw Carter on 2nd May, and the relevant RAE staff four days later, and confirmed that they would proceed immediately with a design on these lines. He also instructed Carter to begin a mock-up immediately while RAE had the essential wind tunnel work already planned out and was to proceed with it in collaboration with Carter and Whittle. Once the twin-engine fighter had become reality, the problems of its design had to be analysed. The close proximity of the two engine nacelles to the fuselage gave rise to a very poor wing junction, which was likely to result in a breakdown of the flow and an early stall of the wing between the nacelles and fuselage. In addition the thick section would produce compressibility effects over this part of the wing.

During a meeting held at RAE in September 1940 Lord Cherwell, Churchill's Scientific Advisor, was convinced by Whittle and RAE's Hayne Constant of the importance of jet propulsion. This extension of interest beyond MAP was one of the reasons why, when at last Beaverbrook and Hennessey became aware of the existence of jet propulsion and the aircraft designed for it, the project took such an important place in their discussions for future developments. At this time the tactical ideas of the RAF were being shaped by the massed night attacks of the Luftwaffe and, as a result, two new fighter requirements made their appearance – a night fighter and a high-altitude fighter incorporating a pressure cabin. Designs from Gloster could adequately meet both – the F.18/40 night fighter (Chapter 3) and the F.9/40 jet fighter, but during December 1940 it became clear that one or other of these designs must give way because the company's design capacity was insufficient to pursue both.

Although existing fighters could be modified to suit the night fighter requirement, the Air Staff was in favour of the specialised Gloster design and the fact that the E.28/39 experimental aircraft had still not flown with its jet propulsion unit made them hesitate to decide on the F.9/40. Air Staff interest was largely sustained by MAP and it was not until the E.28/39 flew that the Air Staff finally dropped the Gloster night fighter, leaving the firm free to concentrate on its jet fighter. On 9th January 1941 Beaverbrook told Gloster 'I wish you to concentrate your design strength on the twin-engined Whittle fighter. This will be your main contribution to my development programme. It is of unique importance [and] to assist you on making this effort, work on the night fighter will stop. A pressure cabin must be provided as soon as possible. On this you should collaborate with Westland, who are to design a Merlin-engined fighter with a pressure cabin' (the Welkin – Chapter 2). Specification F.9/40 was completed in November 1940 to cover the twin-engined jet fighter and its top speed at 30,000ft (9,144m) was not to be less than 430mph (692km/h).

On 24th January 1941 Sir Henry Tizard (who the previous November had replaced Sir Wilfred Freeman as MAP's AMDP) told VCAS that the Research Department was now satisfied that the Whittle engine had reached a sufficient stage of development to permit the placing of production orders. Tizard attached great importance to the jet fighter concept, even though it was as yet unproven, but he felt that it should be possible to achieve practical success in time to influence the war. He completed studies of the jet fighter with various levels of engine thrust against the Spitfire Mk.III and showed that, although the F.9/40 with two 1,400lb (6.2kN) engines was estimated to be much faster than the Spitfire III at 38,000ft (11,582m), its role as an interceptor would be only just as effective as the Spit since it had a poorer take-off and rate of climb. In Tizard's view the main production *must* centre on an engine giving not less than 1,600lb (7.1kN) static thrust at sea level.

A contract for twelve prototypes, DG202 to DG213, was placed on 14th February 1941. Gloster looked at fitting six 20mm cannon but preferred four, regarding the last pair as overload, and for a fighter fitted with 1,640lb (7.3kN) W2B engines the company's brochure predicted a top speed of 385mph

(619km/h) at sea level, a sea level rate of climb of 3,220ft/min (981m/min) and ceiling 46,000ft (14,021m). A final Mock-Up Conference was held in February 1941 and it was estimated that the first prototype would be flying by the end of the year. On 21st May, six days after the E.28/39's landmark first flight, Hawker Siddeley's Frank Spriggs told MAP's J S Buchanan 'There is little doubt that the development of the Gloster Whittle project as a military type is absolutely essential and in view of the very satisfactory progress of the [E.28/39] test machine, such development should be regarded as star priority'. An order for 300 F.9/40s was confirmed on 8th August but the Whittle W2 intended to power them was showing signs of surging and running too hot at high revolutions.

The main security codename given to the F.9/40 was 'Rampage' but by September it was unofficially being called 'Thunderbolt' ('Millet' was also used to screen the F.9/40's first flights from Edgehill and Barford St John). In February 1942 it was agreed that the fighter should be referred to as the 'Gloster F.9/40' rather than using any unauthorised name which now included 'Meteor'. Gloster was loath to suggest a name since the company felt that the secrecy of the project would be better safeguarded if it was referred to by the specification number. However, in early summer 1942 Meteor became the agreed choice.

By late 1942 the twelve prototypes had been reduced to seven but the number was later stretched to eight. At the start of 1942 a maiden flight was expected in May and orders were given forbidding the use of Whittle type engines on dusty aerodromes. Besides Whittle's engine, developed by his firm Power Jets with assistance from Rover and then Rolls-Royce, two other jets had by now made their appearance. One was designed by Frank Halford and built by de Havilland and the second came from Metropolitan-Vickers to the general designs of the RAE and featured an axial compressor (all of the others had centrifugal compressors).

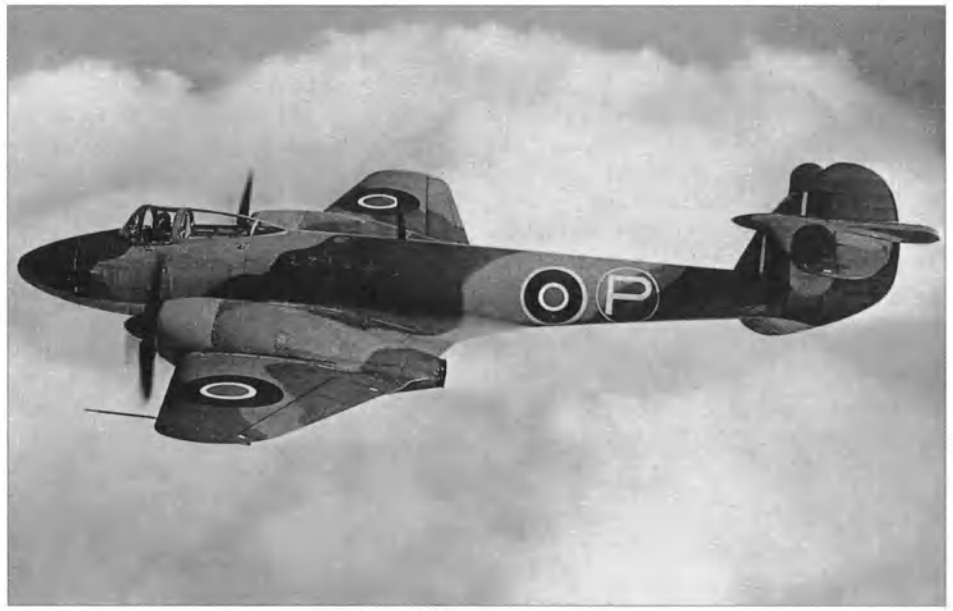
It was intended to modify some F.9/40 airframes to fit these engines but the installation of the MetroVick F.2 (later the Beryl) was difficult; it was found that the simplest solution was to sling the engine under the wing spars which meant practically no spar redesign was necessary. The de Havilland H.1 gave less problems but, being of somewhat larger diameter than the W2B, it needed longer spars for the centre section and a wider nacelle which increased the span. When it became clear that the H.1 was proceeding well, a decision was taken on 26th September 1942 to give the engine precedence over the F.2 and push it forward with high priority, a move that ensured the first Meteor to fly was actually the H.1-powered DG206. A full brochure for an H.1 F.9/40, or Meteor Mk.2, was completed in November 1942. Each engine gave 2,500lb (11.1kN) thrust and so, for what was in all respects a fully operational machine, the predicted top speed (470mph [756km/h] at sea level) was greater than that expected from the W2B version. Fully developed, the H.1 was expected to give 3,000lb (13.3kN) thrust which suggested speeds in excess of 500mph (805km/h) and exceptional rates of climb to high altitude; consequently Gloster declared that this would be a formidable fighter proposition.

Meteor DG204 had two MetroVick F2 axial jets. Eric Morgan

However, some Ministry staff felt that the Meteor was a serious waste of effort and that a large number of highly-skilled workers could be better employed on alternative types like the Merlin 61-powered Mosquito. On 26th October 1942 R S Sorley, ACAS(T), wrote that due to a shortfall in thrust the first Meteor with W2B would be disappointing and it would not be until the 'Stage II' arrived sometime in 1943 that a performance would be available which was comparable to the original requirement. While it would give high speeds at all heights, it was down on climb and unlikely to give before 1944 the full ceiling that the Air Staff required. Sorley added 'by this time we should have the second edition of the Westland Welkin which shows promise of exceeding the Meteor in climb but is lower in speed' (he also noted that the Mosquito X, the standard fighter, was inferior to both).

Sorley declared that the Meteor 'will do no more than serve as a useful high-speed type for a very short while, but it will provide us with a jet-propelled aircraft on which to gain experience of the new technique, which I think is most necessary'. In fact the Meteor's future was uncertain because, with the W2B, it would be outclassed, except possibly in speed, by orthodox fighters. However, thanks to a superior rate of climb jet fighters were seen essentially as 'interceptors' and, with no propeller, they could always outdive a regular type. However, building a small batch of W2B-powered machines would, both technically and tactically, be vital because a great deal of development work was ahead and so much needed to be learnt.

EE401 was a Meteor F Mk.3 fitted with Derwent engines. Eric Morgan



On 20th September 1945 EE227 made its first flight fitted with experimental Rolls-Royce Trent turboprop engines, for which it required small additional finlets.

It was well into 1943 before suitable W2B flight engines were available so the first flight-ready prototype did indeed prove to be DG206 with the H.1, two engines having been delivered by 12th January but derated to 2,000lb (8.9kN) for early runs. DG206 made its maiden flight on 5th March but keeping the existence of jet aircraft secret was not easy; apart from service personnel seeing aeroplanes with no propellers there was always that distinct noise for the public to hear. On 6th August Sorley described to his Minister how, up to now, jets were only allowed to fly from specially cleared airfields, which in practice had amounted to concentrating them at Barford St John (near to Gloster Aircraft) and at Farnborough. This had suited Gloster well but naturally did not satisfy Rolls-Royce or de Havilland who were most anxious to fly them from airfields closer to their factories.

The Air Staff had already gone to considerable trouble to obtain security clearance for an airfield nearer to Derby (Balderton) but each time this involved a great deal of work. It often meant that the dismissal of 'doubtful labour' employed at particular airfields led to either a hold-up in construction work or inevitable delays in operating these aircraft from a desired point. With the steady progress being made in both aircraft and engines, it was correct that the contractors should wish to use their own facilities at Hucknall and Hatfield. This would save so much time both with testing but also if some slight alteration or repair was needed; in addition, once these aircraft were in the air it became impossible to conceal the fact that they were flying. The approaching maiden flight of the de Havilland DH.100 (below) brought matters to a head. It looked as if the aircraft would have to go to Barford St John for its first flight but then Sorley told Geoffrey de Havilland on 13th August that there had been a change in policy and his jet could fly from Hatfield. He suggested however, that it should perhaps operate from a hangar on the far side of the airfield which could be securely guarded and that taxiing should be done in the early morning before the airfield was opened.

On 13th August the Minister of Aircraft Production drew attention to the strict necessity for avoiding any reference to jet aircraft in the press – on no account should there be any publication relating to the development, production or flight of jet aircraft (a piece had appeared in the American publication *Esquire* the previous April). There was, however, no objection to articles examining the theory of jet propulsion in general. The first disclosure of Allied jet work was finally released to the national press on 6th January 1944.

A discussion and review of 'Future Gas Turbine Aircraft Projects' was completed on 8th June 1942 and covered two classes – fighters for which engines were likely to be available in a year's time and bombers for which appropriate engines were required two years hence. It was decided to continue the F.9/40 with W2Bs as an operational type, the F.9/40 with H.1 engines was recognised as an experiment of great interest, the de Havilland E.6/41 (the DH.100) was noted as 'an experimental job in which the twin-boom construction needed close attention from the structural point of view' (RAE were to investigate the boom design) and reference was also made to jet fighter schemes from Supermarine and Westland (below). As a result of discussions on a Gloster fighter scheme known as the 'Ace' (also below), it was decided that a second-string fighter, with a single engine, was required which would have a low-drag wing structurally designed for smoothness.

The fighter engines were the Power Jets W2 (with Rover and British Thomson Houston and including the W2B and W2/500), the Metropolitan Vickers F.2 and F.3 and the de Havilland H.1 (later called Goblin; the W2B/23 later became the Welland). These units further developed were to be considered as bomber engines and it was decided that company's should be found to produce, in addition to the F.9/40 and E.6/41, one single-engined fighter and one tail-first bomber; in fact by now Gloster Aircraft was working on a single-engined jet fighter. In mid-July 1943 Richard Walker assumed full responsibility for the F.9/40 programme which gave Carter the freedom to work on new projects.

Alternative Gloster Jet Fighters

Gloster E.5/42 Ace

The extra power now starting to become available from jet engine developments made the single-engined fighter a more practical proposition and on 31st January 1942, 'because of the possibility of producing engines of bigger output', Carter suggested such a type to Rowe. He estimated that the fighter would have a span of 40ft (12.2m), wing area 285ft² (26.5m²), all-up-weight 9,000lb (4,082kg) and would carry four 20mm guns. The performance figures included a top speed of 440mph (708km/h) at sea level and 490mph (788km/h) at 30,000ft (9,144m), operational ceiling 45,000ft (13,716m) and time to 30,000ft 11 minutes. The aircraft was proposed as the Gloster Ace and Carter said that it merged into one aircraft all of the knowledge and experience that had so far been acquired. It was also clearly associated with the aerodynamic characteristics of the E.28/39 and shared a similar layout, except for a longer fuselage, four cannon housed in the lower portion of a solid nose, wing root intakes and a T-tail (a drawing can be found in James Goulding's book *Interceptor*).

The go-ahead for a trial design was given on 20th July and it was agreed that, because of Gloster's heavy commitment on the F.9/40, the final detail design could be done by 'Jimmy' Lloyd at Armstrong Whitworth Aircraft (a sister company within the Hawker Siddeley Group). The idea of a 'Gloster-Armstrong fighter' was, according to R S Sorley, 'a good idea'. The trial design was received by Lloyd by letter on 27th July and he reported that he had already visited Westland and received a copy of Petter's report 'Jet Propelled Aircraft with Special Reference to High Altitude Operation'.

However, on 30th July it was agreed to let Carter, rather than AWA, carry on with the single-engined fighter. A revised drawing was completed in September which showed a span of 35ft (10.7m), all-up-weight 7,750lb (3,515kg), top speed 490mph (788km/h) at sea level and 520mph (837km/h) at 30,000ft and operational ceiling 48,000ft (14,630m). The Advisory Design Conference was held on 17th December 1942 but prior to this the military load was increased to 2,500lb (1,134kg) from 2,110lb (957kg), which took the gross weight to 8,600lb (3,901kg) (this was revised again on 22nd January 1943 to 8,300lb [3,765kg]). The aircraft's wing structure was based on a single main spar running through the fuselage and several documents called the aircraft the Gloster A.9. Specification E.5/42 covered the project.

On 29th January 29 1943 a contract was placed for three E.5/42s, NN648, NN651 and NN655, each with a single 3,000lb (13.3kN) H.1 unit selected ahead of developed W2Bs. On 19th January Rowe stated that he wanted the E.5/42 to fly 'at the earliest possible moment' and 'in the event of conflict between the Meteor and E.5/42, the latter was to have priority'. The Mock-Up Conference was held at Bentham on 23rd and 24th February and the specification was issued to Gloster on March 26 (some documents refer to it as F.5/42). It requested a maximum speed of not less than 485mph (780km/h) at 30,000ft (9,144m) and the new type was also known as the Gloster-Halford fighter (the earlier projects had been labelled Gloster-Whittle).

The debate regarding the value of the single-engined fighter was considerable. By 10th February 1943 it was felt that the Meteor and the H.1-powered E.5/42 would have approximately the same top speed and climb performance, but this was with H.1s giving 2,700lb (12.0kN) thrust in the Meteor and 3,000lb (13.3kN) in the E.5/42. However, the former could be in service possibly in early 1944 but, allowing for the development of aircraft and engines, the E.5/42 would probably be in service not less than 18 months later. It was felt in some quarters that the E.5/42 was a more desirable aircraft all round than the 'larger Meteor' (a variant intended to have Whittle W.2/500 engines) but it could hardly be in service before mid-1945. In addition the endurance of the H.1 Meteor could be improved quite simply by adding drop tanks.

It appears that the construction of the first 'flying shell' E.5/42 was under way by November 1943 in Gloster's experimental works at Bentham while a 1:4.5 scale model received preliminary testing in RAE's low-speed wind tunnel. In mid-December 1943 studies were also made for alternative engine installations which RAE reviewed as follows:

1. Standard H.1 with 3,000lb (13.3kN) or 3,300lb (14.7kN) thrust – mean fuselage diameter 5ft 0in (1.5m), all-up-weight 8,500lb (3,856kg), maximum speed at 30,000ft (9,144m) 540mph or 560mph (869km/h or 901km/h). At the time the H.1 was only giving 2,300lb (10.2kN) so the chance of getting 3,300lb seemed remote.
2. Scaled-up Halford of 3,500lb (15.6kN) or 4,000lb (17.8kN) – respective figures were 5ft 7in (1.71m), 9,500lb (4,309kg) and 545mph or 560mph (877km/h or 901km/h). These power units were 'very hypothetical'.
3. The American 4,000lb thrust GEC Type I.40 – 5ft 9in (1.75m), 9,600lb (4,355kg) and 550mph (885km/h). There were some CofG difficulties which RAE said had been neglected in establishing the weight etc.
4. The 4,000lb MetroVick F.2/4 gave a 4ft 6in (1.37m) mean fuselage diameter but CofG difficulties were prohibitive and detail performance estimates had not been made.
5. Whittle 4,000lb W4/100 – 5ft 8in (1.73m), 10,200lb (4,627kg), and 545mph (877km/h). Here the CofG difficulties were serious and not taken into account when establishing weights.
6. Rolls-Royce B.37 of 2,500lb (11.1kN) or 2,800lb (12.4kN) – 4ft 0in (1.22m), 7,500lb or 7,800lb (3,402kg or 3,539kg), 515mph or 530mph (829km/h or 853km/h). The B.37 was expected to give 2,500lb in its present form and might be developed to 2,800lb. A low rate of climb was the main disadvantage in this version.

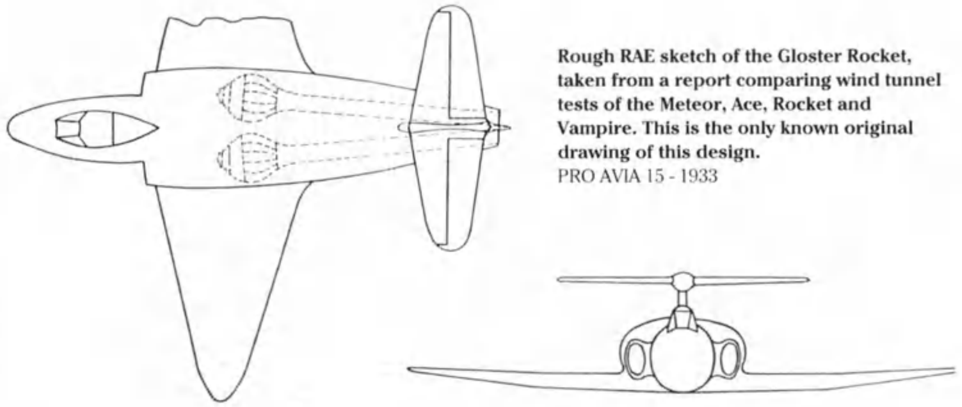
Despite being seen as a desirable aircraft, the E.5/42 faded away to be replaced by a larger single jet fighter, the E.1/44 Ace described shortly.

Gloster Rocket

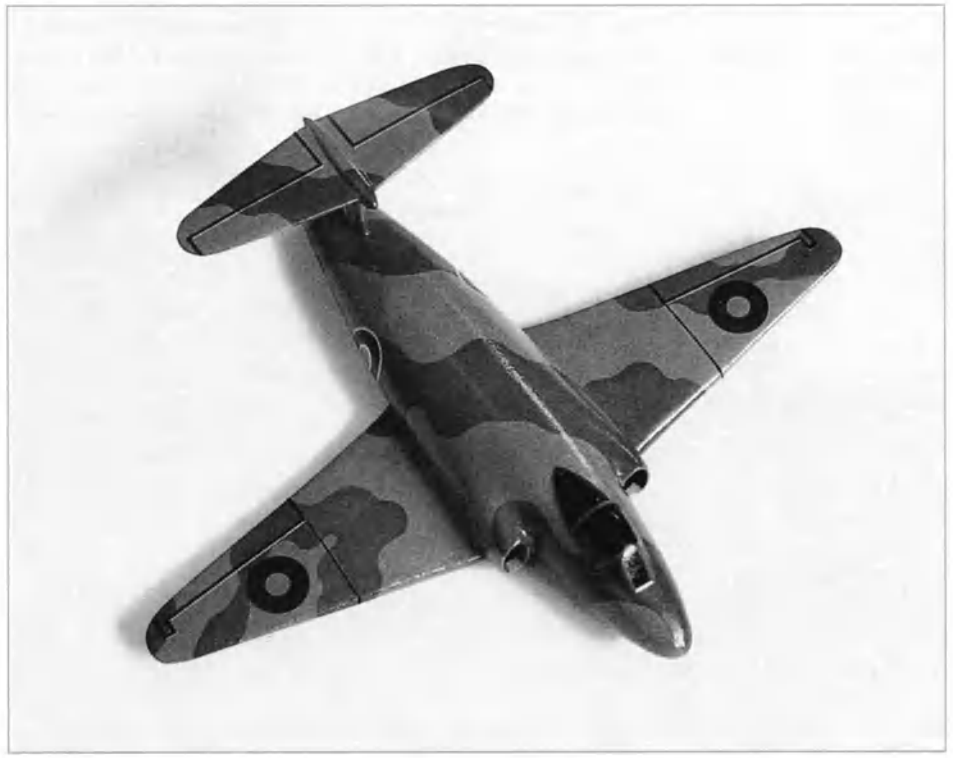
The Gloster Rocket proposal was briefly described in a brochure produced at the end of August 1943, though a version had been drawn in July as the P.150. Gloster stated that it 'marked the introduction of a new design for a fighter and shows the possibility of a further important advance along the road towards ultimate development. It outlines the prospect of achieving a low-level speed of 550mph (885km/h) and a climb rate, commencing at sea level, of about 9,000ft/min (2,743m/min).'

The design was similar to the E.5/42 except that it had a twin side-by-side engine installation which functioned almost as a single unit. Two Rolls-Royce B.37s occupied the same sort of position in the rear fuselage as the Halford engine had occupied in the E.5/42 and the fuselage width was suitably increased in order to accommodate the new format. This extra width was just about the level necessary to duct the air intakes on either side of the front part of the fuselage and it was expected that the combined thrust of the two units when fully developed would be 5,000lb (22.2kN). Such an increase in power was much more than could be effectively utilised from a single engine in an aircraft of this type; any engine that was large enough for this purpose would be prohibitive in weight and bulk.

There was little fundamental difference between the E.5/42 and the Rocket. What difference there was mostly concerned the fuselage behind the cockpit and to a lesser extent the wing centre section. The front part of the fuselage, outer wings, main undercarriage and tailplane were expected to be the same except, in certain places, for some extra strength or stiffness. The front fuselage was important since it housed the pilot's pressure cockpit and practically all of the military equipment. The basic design was closely allied to the E.5/42 and so it was anticipated that, if this proposal was considered acceptable for early development and production, progress in the design and construction of a prototype would be rapid. From a design standpoint Gloster felt that the project was recommended as a type of outstanding technical interest. Both the E.5/42 Ace and the Rocket used an RAE 'high-speed' wing section first developed and fitted to the E.28/39.



Rough RAE sketch of the Gloster Rocket, taken from a report comparing wind tunnel tests of the Meteor, Ace, Rocket and Vampire. This is the only known original drawing of this design.
PRO AVIA 15 - 1933

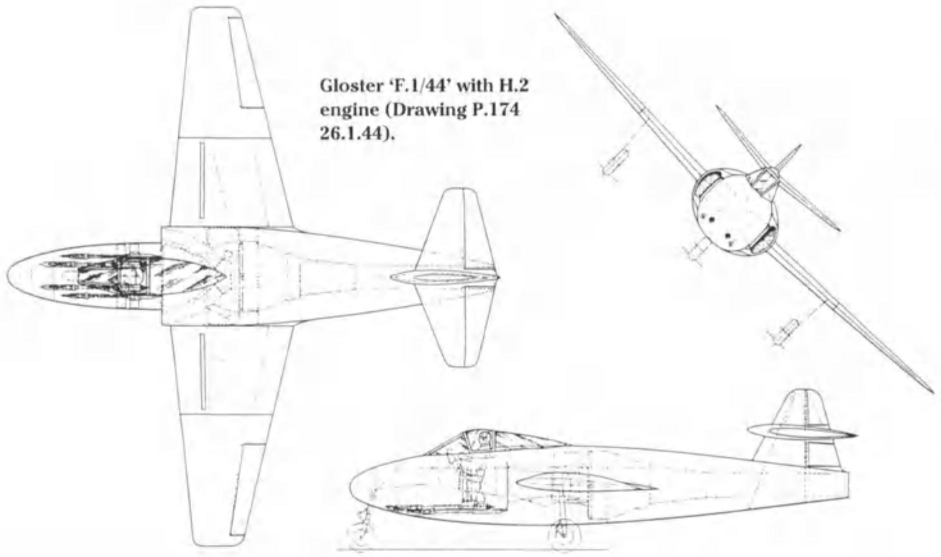


Model of the Gloster Rocket. Joe Cherrie

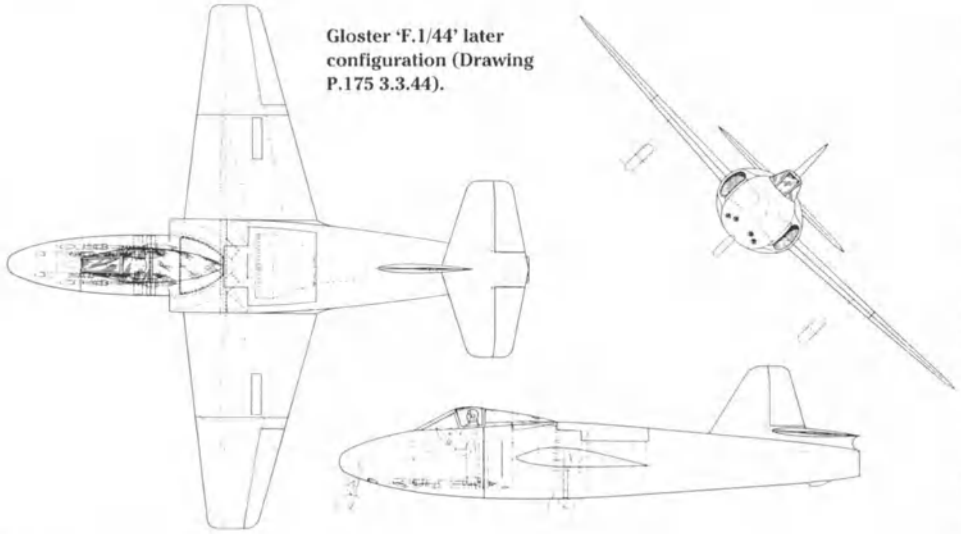
The Rocket's twin B.37 jets would each supply 2,200lb (9.8kN) thrust to give an estimated top speed of 545mph (877km/h) at sea level, rate of climb at sea level 7,650ft/min (2,332m/min), time to 30,000ft (9,144m) 5.3 minutes, operational ceiling 52,000ft (15,850m) and absolute ceiling 54,000ft (16,459m). Later developments were expected to offer 2,500lb (11.1kN) and would amend these figures to 560mph (901km/h) at all heights, 9,150ft/min (2,789m/min), 4.3 minutes, 54,000ft and 55,000ft (16,764m). The data allowed for compressibility but if this factor was removed the equivalent top speeds for normal engines were 573mph (922km/h) at sea level and 684mph (1,101km/h) at 38,000ft (11,582m), and for the more powerful developments 611mph (983km/h) at sea level and 730mph (1,175km/h) at 39,000ft (11,887m). The Rocket's fuel capacity was 250gals (1,137lit) and maximum range at sea level 200 miles (322km).

On 31st August 1943 Rowe reported on a talk with Whittle about the possible installation of his W4/100 engine in the E.5/42 Ace, but it was thought to be 'not very suitable ... the job can be better done by using two of the smaller units as proposed in the Rocket design arrangement.' Whittle was at first somewhat reluctant to accept the close-coupled twin scheme in preference to one larger engine but later in the discussion agreed that the large engine was generally unsuitable except perhaps for a tail-first or tailless arrangement. Early RAE calculations suggested a top speed for Rocket of 449mph (722km/h) at sea level and 480mph (772km/h) at 30,000ft, but on 22nd November RAE reported that it liked the new design which had 'very much improved aerodynamics over the F.5/42 and less drag'.

However, an earlier meeting held at MAP on 9th October between Rowe, Dr Roxbee Cox, Dr Garner and Frank Whittle had discussed a high-speed project for Miles (the M.52 supersonic research aircraft below) and the Rocket. The latter now showed a tricycle undercarriage but Whittle was not very enthusiastic about the scheme and used the opportunity to point out that if they were going for a super fighter, and with an aeroplane which had not yet gone beyond the drawing stage, they should make a proper job of it and put in the powerplant most suited for the purpose, instead of making it with either B.37s or W2/700s. A full specification needed to be laid down which Rowe defined as the Meteor military load and endurance but with a top speed of the order of 600mph (965km/h). The Rocket was a short-lived project and never close to being built.



Gloster 'F.1/44' with H.2 engine (Drawing P.174 26.1.44).



Gloster 'F.1/44' later configuration (Drawing P.175 3.3.44).

Gloster E.1/44 Ace

The facts are not clear but in late 1943 and early 1944 the original E.5/42 Ace was either abandoned for a new design or drastically altered. The result was a new project, still called the Ace, and the E.5/42 prototypes were cancelled on 2nd February 1944.

The first versions of the modified aircraft – or the bridge between the two (drawings are not available) – appear to have been the P.171 and P.172 projects with 4,000lb (17.7kN) and 3,300lb (14.7kN) variants of the H.1 respectively. P.171 had a span of 36ft 0in (11.0m), wing area 230ft^2 (21.4m^2) and carried 220gals (1,000lit) of fuel; P.172's span was 33ft 6in (10.2m), wing area 200ft^2 (18.6m^2) and fuel capacity 195gals (887lit). Their performance with four cannon was summarised as follows: P.171 had an all-up-weight of 10,100lb (4,581kg), top speed 600mph (965km/h) at sea level, 595mph (957km/h) at 30,000ft (9,144m), rate of climb 6,300ft/min (1,920m/min) at sea level, time to 30,000ft 6.5 minutes, service ceiling 52,000ft (15,850m) and absolute ceiling 54,000ft (16,459m). The P.172's respective figures were 8,800lb (3,992kg), 575mph (925km/h), 585mph (941km/h), (maximum speed was 595mph [957km/h] between 10,000ft [3,048m] and 20,000ft [6,096m]), 5,700ft/min (1,737m/min), 7.5 minutes, 49,000ft (14,935m) and 52,000ft.

A full brochure was completed in late January 1944 and Gloster felt that the outstanding feature of the design was the very high performance attainable with the de Havilland H.2 series engine (later called Ghost) which had a declared thrust of 3,600lb (16.0kN) and was expected to give 4,000lb (17.7kN) with full development. Drawing P.174 of 26th January 1944 outlined 'a compact and aerodynamically exceptionally clean machine'. Basic drag had been reduced to a remarkably low figure, about half of that for the Meteor, which Gloster noted was an indication of the progress that had been made. It also emphasised the importance of reducing basic drag as opposed to providing more thrust. It was felt that an engine giving about 4,000lb thrust seemed to be as good a compromise as could be expected for a single-engined jet fighter and there was little gain, if any, from using engines that exceeded the H.2's fully developed 4,000lb. An alternative examination had been made to consider the American GEC engine as a possible alternative, but this unit was designed to operate in a pressure compartment or nacelle and the air ducts were much larger than those required for the H.2 (where the air ducts were connected directly to the engine compressor casing). Thus it was not regarded as an altogether practical alternative.

The exceptionally high-speed performance of the P.174 was such that a reasonable limit in dive conditions would give rise to some very severe strength and stiffness requirements. At sea level a speed of 600mph (965km/h) corresponds to a Mach number of 0.80 and at 40,000ft (12,192m) the speed equivalent to 290mph (467km/h) corresponds to Mach 0.90. To reduce some potentially severe design problems and increases in weight, Gloster stated that it was most desirable to limit the design's diving speed to 600mph EAS and the corresponding Mach number at this speed to 0.90. This represented a negligible limitation on level speed at sea level and a greater limitation on the diving speed and made it possible to establish the aircraft's gross weight with two guns (the preferred option) at 10,000lb (4,536kg). The combination of high wing loading and thin wing section (both dictated by performance requirements), together with the proposed symmetrical wing section, had also led to a higher stalling speed than was considered desirable. To offset this Gloster said that it would be necessary to fit an effective flap system and to consider drooping the ailerons when the flaps were in operation.

Span was 36ft (11.0m), length 34ft (10.4m), gross wing area 230ft^2 (21.4m^2), thickness/chord ratio 10% at the root and 6% at the tip, internal fuel 220gals (1,000lit) and gross weight with four guns 10,550lb (4,785kg). With four guns the top speed figures were the same as the P.171, rate of climb at sea level 6,000ft/min (1,829m/min), time to 30,000ft (9,144m) seven minutes, operational ceiling 50,000ft (15,240m) and absolute ceiling 52,000ft (15,850m).

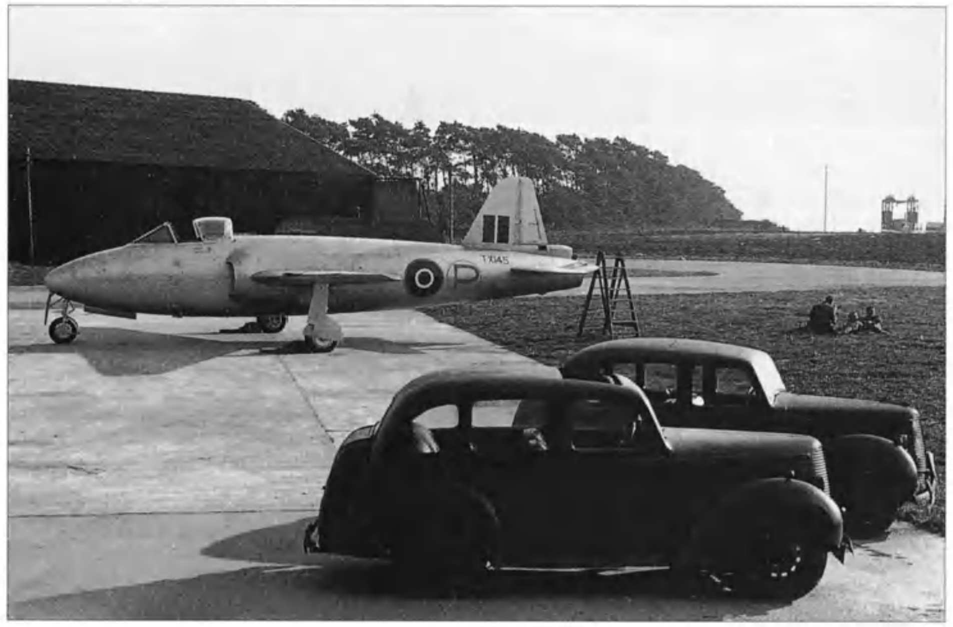
Specification F.1/44 was raised in February 1944 to cover the aircraft and by early March, shortly after the Advisory Design Conference, it had been decided to regard the four gun assembly as the normal load and to provide more fuel. These changes made the aircraft a little larger and the bigger version (drawing P.175 of 3rd March) also accommodated an engine of increased diameter designed to produce 4,400lb (19.6kN) in the fully developed condition rather than the originally planned 4,000lb (17.8kN); gross weight had increased to 11,700lb (5,307kg). As a result of these changes it had been possible to arrange for the air brake to operate clear of the tailplane and this had made it convenient to bring the tail closer to the fuselage and thus dissociate it from the fin structure. The fin had accordingly been 'stepped' forward of the tailplane, an anticipated advantage in maintaining satisfactory spinning characteristics.

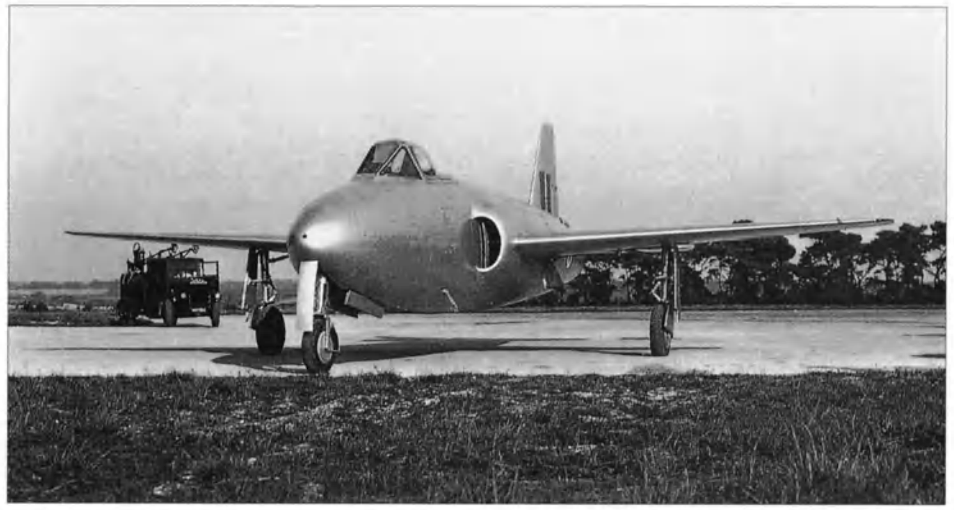
Span was now 38ft (11.6m), length 37ft (11.3m), gross wing area 265ft^2 (24.6m^2) and total internal fuel 295gals (1,341lit). With 4,000lb thrust top speed at sea level was 580mph (933km/h), at 30,000ft (9,144m) 570mph (917km/h), sea level rate of climb 5,000ft/min (1,524m/min), time to 30,000ft 9.5 minutes, operational ceiling 44,000ft (13,411m) and absolute ceiling 48,000ft (14,630m). With 4,400lb of thrust these figures became 600mph (965km/h), 590mph (949km/h), 5,700ft/min (1,737m/min), 8.5 minutes, 47,000ft (14,326m) and 49,500ft (15,088m). The specification was soon renumbered E.1/44 and by early July the design was very close to the form that was eventually built; however, Gloster shortly afterwards offered an H.2 variant (drawing P.181) or one with a single Rolls-Royce B.41 Nene engine (P.190 dated 22nd September).

The fundamental difference between these engines was that the Halford made use of high-velocity air passing through ducts directly connected to the compressor casing but the Rolls required that the air should be expanded to a relatively low velocity before entering the engine and a suitable ducting arrangement for it presented a major problem on account of size in restricted space. On the Halford-engined aeroplane the air ducts passed through the main wing spar before directly connecting to the compressor casing and these ducts had their entry areas disposed on either side of the fuselage adjacent to the wing roots. When the Rolls engine was installed the ducts, on account of their larger size, passed over and under a straight-through spar before being connected to the plenum chamber surrounding the engine. These differences affected the position of the fuel tanks behind the main spar, there being two for the Halford and one central tank for the Rolls; thus it was impracticable to consider replacing one unit with the other in the same aeroplane.

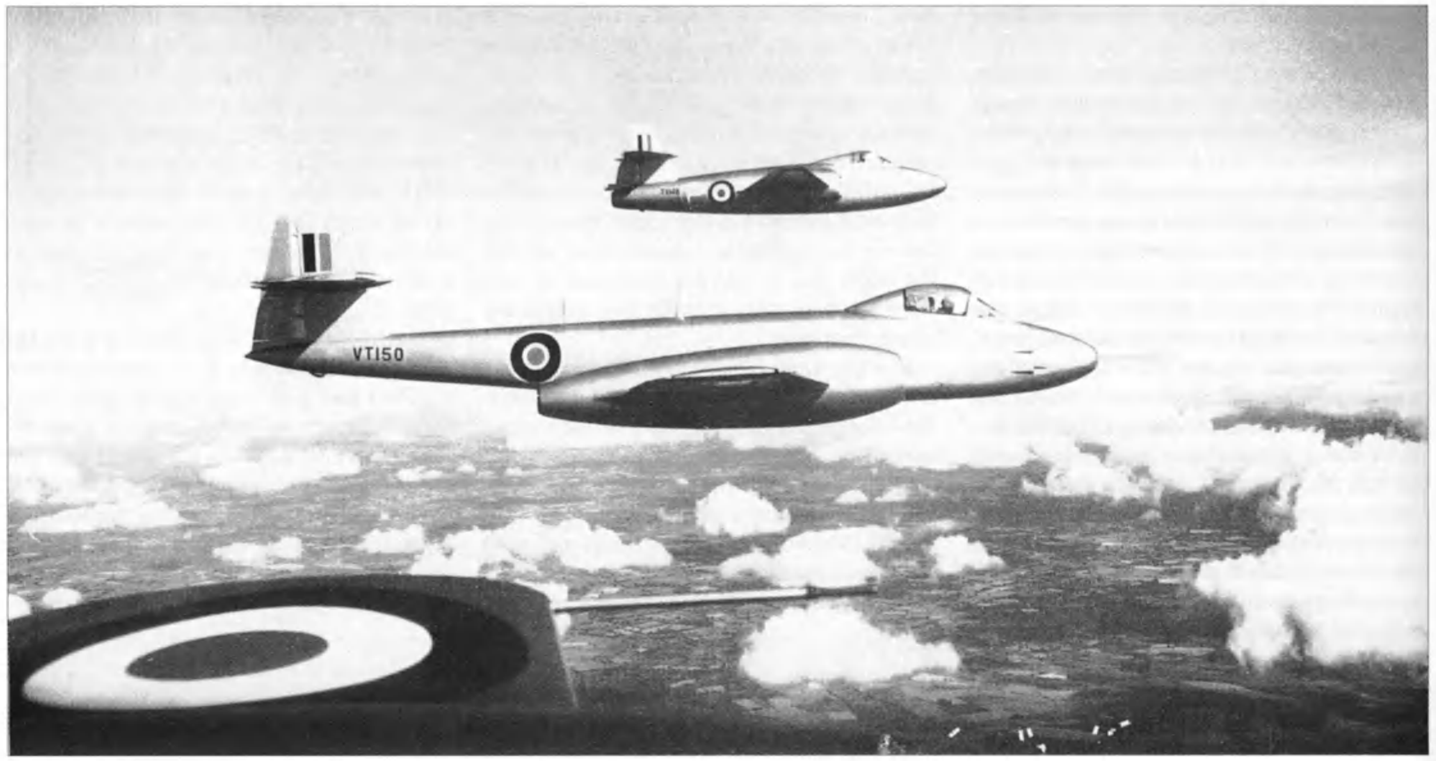
In early December 1944 Gloster's target date to complete the first aircraft had become the following August. By May 1945 the aircraft was to be fitted with either a de Havilland Ghost 10 or a Nene and the prototype line up had been laid down as SM809, TX145, TX148 and TX150 (the 'strength test' airframe) with Nenes and SM801 and SM805 with the Ghost; however, when the E.1/44 finally flew it was powered by a Nene. Thanks to the low priority given to it, progress on the Ace was slow while Gloster's enthusiasm for the project gradually faded; in fact the aircraft did not fly until 9th March 1948, by which time it was rather out of date. In the end only TX145 and TX148 ever flew, a production order placed on 5th September 1945 and covered by Specification F.23/46 was cancelled, and plans for a Nene II version were dropped in August 1946.

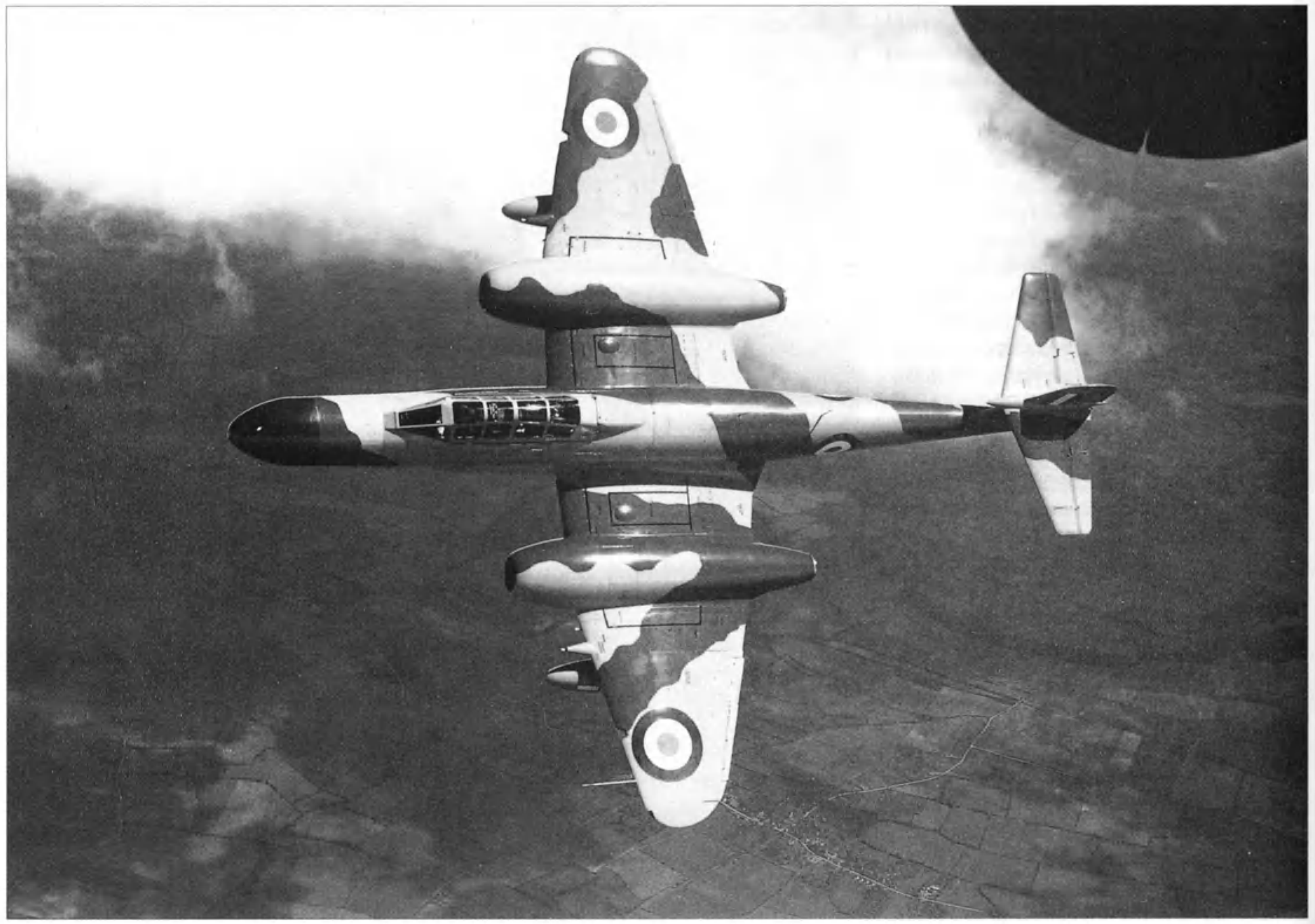
The E.1/44 proved to be something of a failure and its nickname, the Gloster Gormless, signified just how lowly it was rated. It certainly never came anywhere near matching the achievements of its famous Meteor stablemate but it did contribute a new tail layout to that aircraft, which became the Meteor F Mk.8. The new rear fuselage and tail arrangement were first drawn on 2nd September 1946 as the P.212.





Views of the Gloster E.1/44 Ace prototype TX145, with the original tail, taken at Moreton Valence in 1948. Jet Age Museum





Gloster Meteor Developments

After the war the Meteor went from strength to strength. The first versions lacked performance but the F Mk.4 fitted with Rolls-Royce Derwent 5s brought the type to maturity and was built in large numbers. However, by 1947 it was clear that the fighter, if it was going to remain competitive with rival products, would need updating and so Gloster began work on a 'second generation'. Late Mk.4s had a longer nose but the more forward position of the guns and ammunition, in relation to the whole aircraft, ensured more pronounced movements in CofG occurred as the ammunition and fuel were used up. The original tail was unsuited to cope with the pitch-up instability this created but the angular tail fitted to the E.1/44 Ace was; this was tried on RA382 and showed good handling. Consequently Mk.4 VT150 was converted to a full F Mk.8 prototype and flown on 12th October 1948. To prove the new tail, the old style was tried on VT150 and this confirmed the superiority of the later version.

Armstrong Whitworth Night Fighter Meteor
Soon after the war the need to replace the Mosquito night fighter became critical and Mk.3 Meteor EE348 was tested with a nose-mounted AI radar as part of the F.44/46 night fighter programme, which eventually led to the Gloster Javelin (see *British Secret Projects: Jet Fighters since 1950*). But progress was slow and an interim Mosquito replacement with improved performance was required to fill the gap. Gloster's first brochure was prepared in October 1948 and showed a converted two-seat Mk.7 Meteor trainer, but the company was fully stretched by its commitments to single-seat Meteors and so the night fighter was eventually passed to Armstrong Whitworth. Specification F.24/48 was issued on 12th February 1949 to cover the NF Mk.11 interim night fighter with AI.Mk.10 radar, a mock-up was completed at the end of 1948 and Mk.7 VW413 was converted into a prototype with a 4ft (1.2m) longer nose. It was flown on 28th January 1949 and in March the Mk.8 tail was added which stretched the length to 48ft 6in (14.8m); to save time the NF Mk.11 used as much existing Meteor structure as possible. The first full prototype, WA546, flew on 31st May 1950 and production orders followed for this version and for the later NF Mks.12, 13 and 14.

Opposite page:

Gloster Ace TX148 was fitted with an alternative tail arrangement. Meteor Mk.4 VT150 was rebuilt with this later Ace-type tail to become the F Mk.8 prototype and was photographed from a Meteor Mk.7 together with TX148. Jet Age Museum

An Armstrong Whitworth Meteor NF Mk.11.
Barry Guess, BAE Systems, Farnborough

Gloster was not the only company to work on jet aircraft during and just after the war, others became involved but the extent of their work varied. However, more jet aircraft design was undertaken in Britain at this time than has probably ever previously been acknowledged.

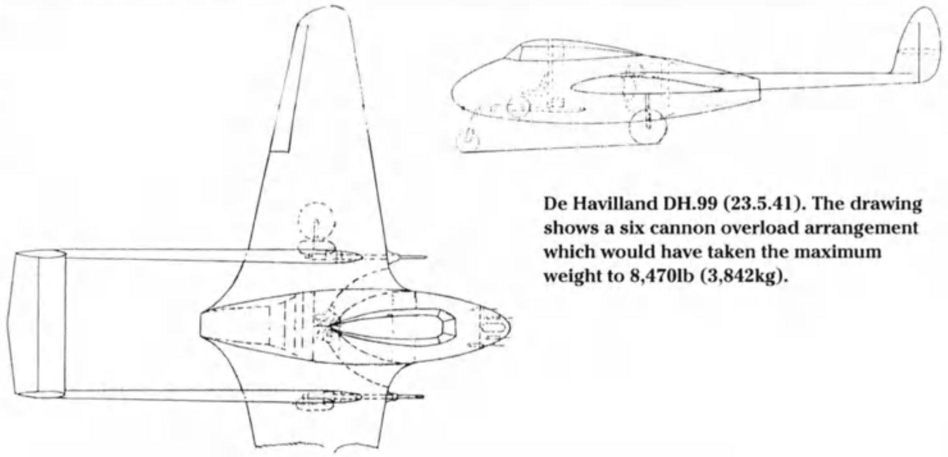
De Havilland Vampire and Venom

Work proceeded fairly quickly on Frank Halford's H.1 Goblin which was larger and, with thrusts of up to 3,000lb (13.3kN), more powerful than Whittle's W2B. This additional power made a single-engined fighter a more viable proposition and, at the end of April 1941, negotiations were initiated by Sir Henry Tizard with Halford and de Havilland for a project to build an airframe to accommodate Halford's engine. The suitability of this form of propulsion for high-speed bombing without rear defence was immediately obvious and the possibilities for this purpose, set out in considerable detail, were communicated to the Ministry in 1942. They were not taken up but it was finally decided that the alternative fighter application should proceed on the grounds that this would be more important as a national insurance against the enemy sending jet bombers over Britain.

De Havilland DH.99 and DH.100
De Havilland's first jet fighter proposal was called the DH.99 and was detailed in a brochure dated 6th June 1941. It was an all-metal twin tail boom aircraft with four cannon housed beneath the cockpit; it had a single wing spar with a D-nose torsion box and was fitted with metal-covered ailerons and slotted flaps. The rudder empennage was carried on tail booms to eliminate any interference from the engine exhaust; this also avoided the necessity for a long tail pipe, and a nosewheel undercarriage was used. The estimated performance with 2,700lb (12.0kN) of thrust was 445mph (716km/h) maximum at sea level, rate of climb at sea level 4,590ft/min (1,399m/min), time to 30,000ft (9,144m) 9.6 minutes and operational ceiling 45,400ft (13,838m).

The design was criticised by MAP's Capt Liptrot for presenting too little detail while its structure weights were considered rather optimistic; Liptrot was also doubtful about the performance estimates. However, in late July 1941 Rowe decided to go ahead with the project and on 5th August Sorley confirmed that they were ordering a de Havilland fighter with the Halford engine. In November 1941 the DH.99 designation was briefly allocated to a development of the Mosquito with two Napier Sabre piston engines, which later became the DH.101, and another twin-Merlin project was the DH.102 to be built to B.4/42 (Chapter 5). However, on 29th December 1942 the Air Staff decided that it did not want the B.4/42 bomber, which relieved the load on de Havilland's design staff (in fact the company had been working on these lines for some weeks).

By 11th November 1941 the jet fighter had been renumbered DH.100 and was eventually built of mixed wood and metal construction, the pilot essentially being housed in a wooden pod. On 13th February 1942 de Havilland's C C Walker, in reply to a suggestion that the fighter should be dropped for a jet bomber, told N E Rowe 'when we started on this design, the idea was to quickly produce a fully operational jet-propelled fighter in case



De Havilland DH.99 (23.5.41). The drawing shows a six cannon overload arrangement which would have taken the maximum weight to 8,470lb (3,842kg).

Opposite page:

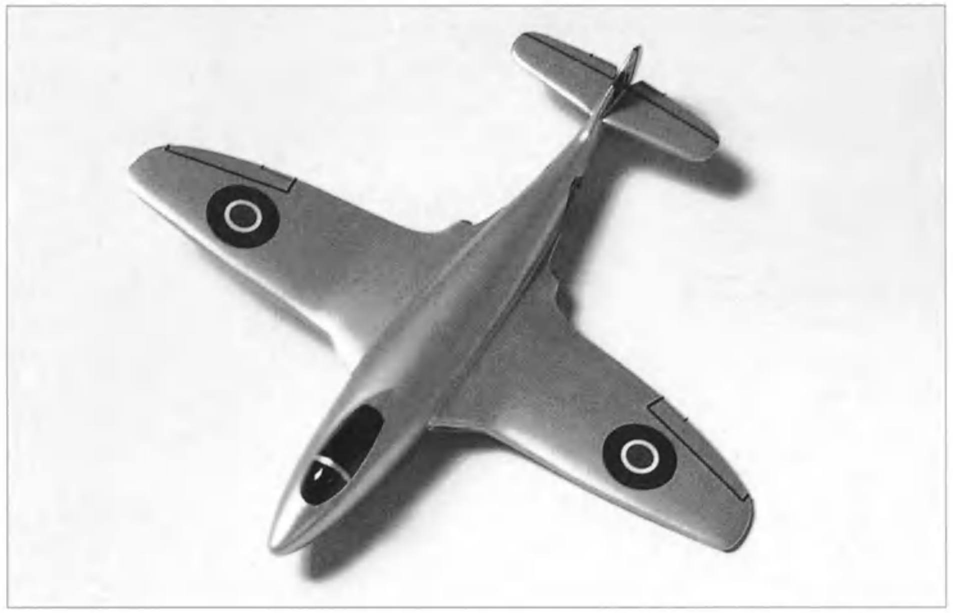
Line up of RAF Vampire F Mk.1s with TG311 nearest. Barry Guess, BAE Systems, Farnborough

The second de Havilland Venom prototype was VV613.

This page:

WM515 was a de Havilland Sea Venom NF Mk.20. Barry Guess, BAE Systems, Farnborough

Model of the Hawker P.1040 with 'Tempest' wings made by Joe Cherrie Snr. It is possible that this layout was actually the P.1035.



the enemy had a similar project in hand. We are aware that twin tail booms have sometimes been regarded with suspicion, we cannot, however, see anything in this beyond the purely engineering problem of giving the known and necessary degree of stiffness to the booms. The case, therefore, for our proceeding with the fighter seems to remain as strong as it was six months ago'.

Two prototypes, LZ548 and LZ551, were authorised on 22nd April and specification E.6/41 was raised to cover the project. On 20th September 1943 the DH.100, Britain's second jet fighter, which for a period was called the 'Spider Crab', made its first flight from Hatfield. A major problem during the flight test phase was 'snaking' (directional instability) which brought a stream of changes to the fin shape and tail arrangement before it was sufficiently cured. Production aircraft entered service as the Vampire and served both the RAF and overseas air forces.

De Havilland DH.112 Venom

The Venom began life as the Vampire FB Mk.8, but this version featured a new thin wing and more powerful de Havilland Ghost 103 engine. The original 'Thin Wing' Vampire proposal was made on 31st March 1948 and showed 10% larger intakes, about 22° of sweepback on the leading edge and curved wingtips. With much recent discussion on high-altitude interception, de Havilland noted that 'the present RAF fighters will be in service for five to six years. It will take time to get a new fighter currently at the preliminary stage into service and therefore everything possible should be done to develop current jet fighters as high altitude interceptors'. The Vampire, with its low wing loading, good manoeuvrability and small turning circle, was particularly suited to high-altitude work and the thin wing improved the Mach performance and made use of the Ghost's extra power. There was nothing experimental about the proposed changes and the new engine added about 600lb (272kg) of weight.

On 15th July Air Marshal W A Coryton wrote 'it would seem that the rib and spar design and method of attaching the covering will be exactly similar to the Vampire, no new fundamental design principles are introduced. De Havilland may go ahead even without our support as the aircraft will find a ready sale as an interceptor in foreign markets'. Consequently there would be no need to direct any high-grade design staff to the project and risk any detriment to the company's existing RAF commitments (which included the new DH.110 jet fighter). The project went ahead and by early September had been named Venom. The first Venom prototype VV612 flew on 2nd September 1949 and the type became an interim fighter-bomber to fill the gap between the Meteor and Vampire and the new Hawker Hunter and Supermarine Swift jet fighters. In due course night fighter and naval (Sea Venom) versions were developed and the type served in numbers throughout the 1950s, both in the UK and overseas.

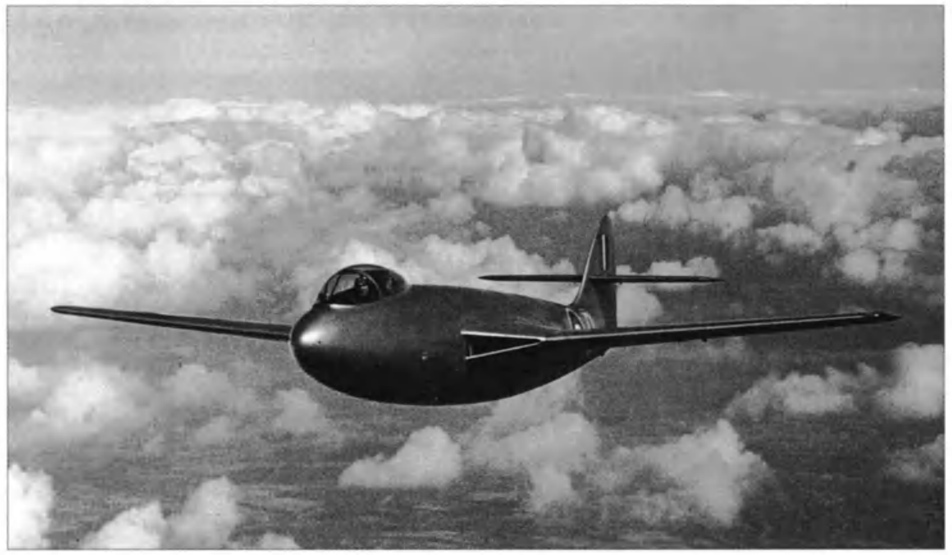
Hawker Sea Hawk

Hawker P.1040

Hawker's first jet-powered design was the P.1011 project of 1941, which was an exercise in fitting Whittle units into the P.1004 high-altitude fighter. The origins of the Sea Hawk began with the P.1035 of 1944 which was described as an F.2/43 Fury with a Rolls B.41 jet installed in the centre fuselage; the piston Fury's elliptical wings were retained but the project featured air intakes in the wing and a split exhaust pipe. Early in November 1944 Mr.

Wardle, DOR, and N E Rowe visited Claremont House in Esher to discuss jet aircraft (Claremont was the wartime base for Hawker staff involved in the design of new aeroplanes). A single engine was suggested and a few days later Rowe supplied particulars for a 6,000lb (26.7kN) Rolls-Royce unit; soon afterwards Hawker sent Rolls details of a bifurcated pipe scheme for investigation. On 22nd December a single-seat fighter aircraft with bifurcated (split) jet pipes and B.41 Nene was drawn under the designation P.1040, which was a cleaned-up P.1035 with straight tapered wings and virtually nothing left over from the Fury.

The Nene had a double-sided centrifugal compressor and it was considered sensible to place the intake as close as possible to it because an early criticism of single-engine jet aircraft with nose intakes and long pipes was that the whole fuselage was full of wind and lacked sufficient space for equipment and fuel. A long jet pipe meant large energy losses, a critical aspect because of the low power of early engines, and P.1040's intake and bifurcated pipe arrangement was seen as a way of keeping pipe length and energy loss to a minimum. It also proved to be the optimum aerodynamically, despite Rolls-Royce needing some convincing as to its suitability, and was probably the most important and innovative feature on the P.1040. The elimination of intake and exhaust ducting within the fuselage allowed Hawker to fit large-capacity fuel tanks both ahead of and behind the engine, a most unusual situation which kept the fuselage symmetrical about the CofG. Early jet engines were weighty objects and thus had to be kept as close to the aeroplane's CofG as possible.



Hawker P.1040 prototype VP401 photographed in 1948.

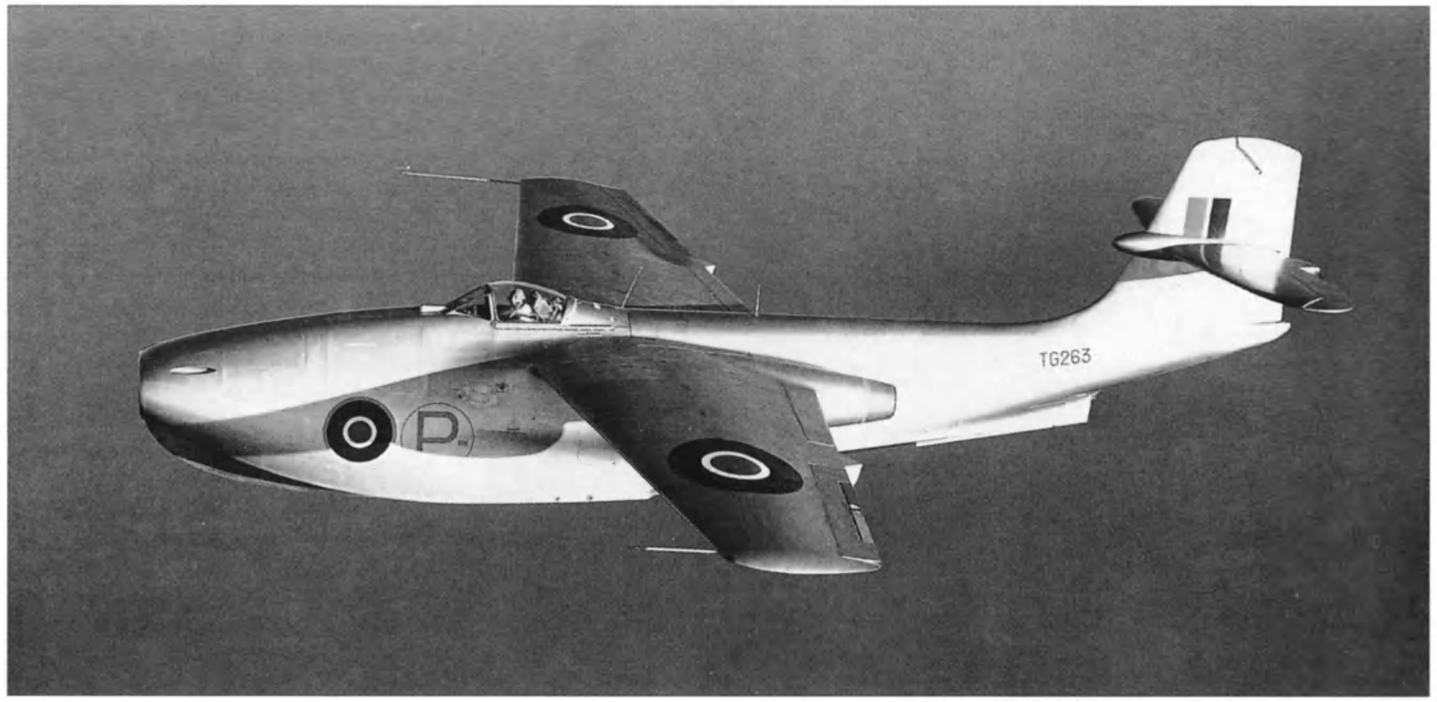
VP422
ROYAL NAVY
VP422
VP422

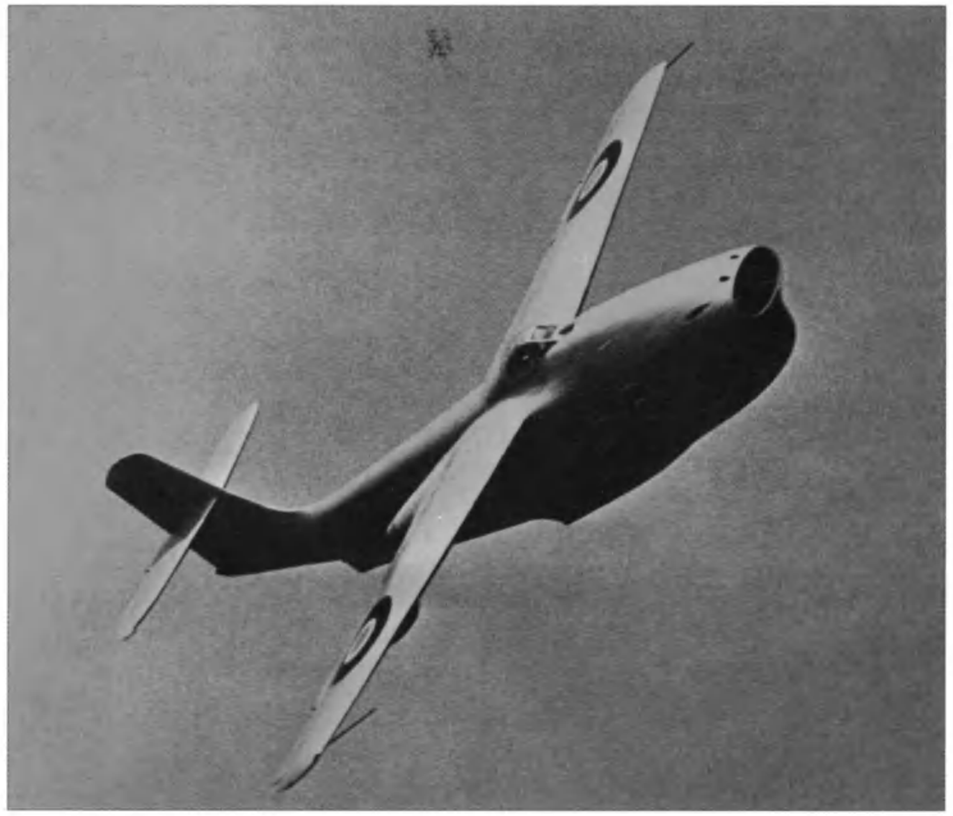
The third Hawker Sea Hawk prototype was VP422.

The first P.1040 brochure was completed in January 1945 and confirmed that the unique bifurcated pipe (patented the following month in the name of J V Stanbury) made room for a large fuel capacity in the tail. Span was 36ft 6in (11.1m) and length 37ft 2in (11.3m). The project was generally approved by Rowe and Wardle and, after seeing it, Sir Wilfred Freeman said 'go right ahead'; the aircraft was sometimes called the 'Fury replacement'. A full tender was submitted to Rowe on 27th February and he felt justified in accepting the Nene since it offered good performance and range while lending itself to an experimental rocket boost installation for improving the rate-of-climb. Design work commenced in March but the air intakes received some criticism. This problem was not cleared by RAE until 21st September 1945, when they were declared 90% efficient, but it had already been agreed that the aeroplane was a considerable advance on present types. Early in October a new combined tender was submitted which comprised the P.1040, the P.1047 (a swept-back version with a rocket motor) and the P.1046 (naval swept-wing version with a rocket).

During December Admiral Slattery visited Kingston and expressed great interest in the project but the company was later advised by Rowe that, at this stage, the P.1040 was not regarded by the Air Staff as one of its new types (allegedly because it offered little improvement in performance over the Meteor). Fortunately the Naval Staff saw it as a support fighter and suggested that the design should be reschemed around the longer but more powerful Rolls-Royce AJ.65 axial jet (later the Avon). However, this second project (the highly swept-wing P.1049 fleet fighter with single AJ.65) was rejected by Hawker in mid-January 1946 as impractical since it would need swept-back wings to balance placing a pilot in the nose, a necessary move to assist deck landing. Swept wings were considered undesirable for the Fleet when the Nene lent itself to a conventional wing arrangement.

On 21st February 1946 an order was placed for three prototype P.1040 general purpose and long-range naval fighter and strike support aircraft. Specification N.7/46 was allotted to the project and in June Hawker was advised that the official target date for the first flight of the first machine, without folding wings, was February 1947; the final Mock-Up Conference was held on 10th and 11th October. Metal cutting began during October 1945 but it was November 1946 before the first centre fuselage was joined in the Experimental Department to its front section. Work was then interrupted and delayed by the ferociously hard winter of 1947 and the national crisis that this created. The consequent cutting off of heat and light closed the entire works from 10th to 28th February and this, coupled with other problems, delayed the P.1040's first flight; however, the first example, VP401, made a satisfactory maiden sortie on 2nd September 1947. The P.1040 was never ordered for the RAF but did enter naval service as the Sea Hawk. In addition the first of two swept-wing P.1052 conversions flew on 19th November 1948.

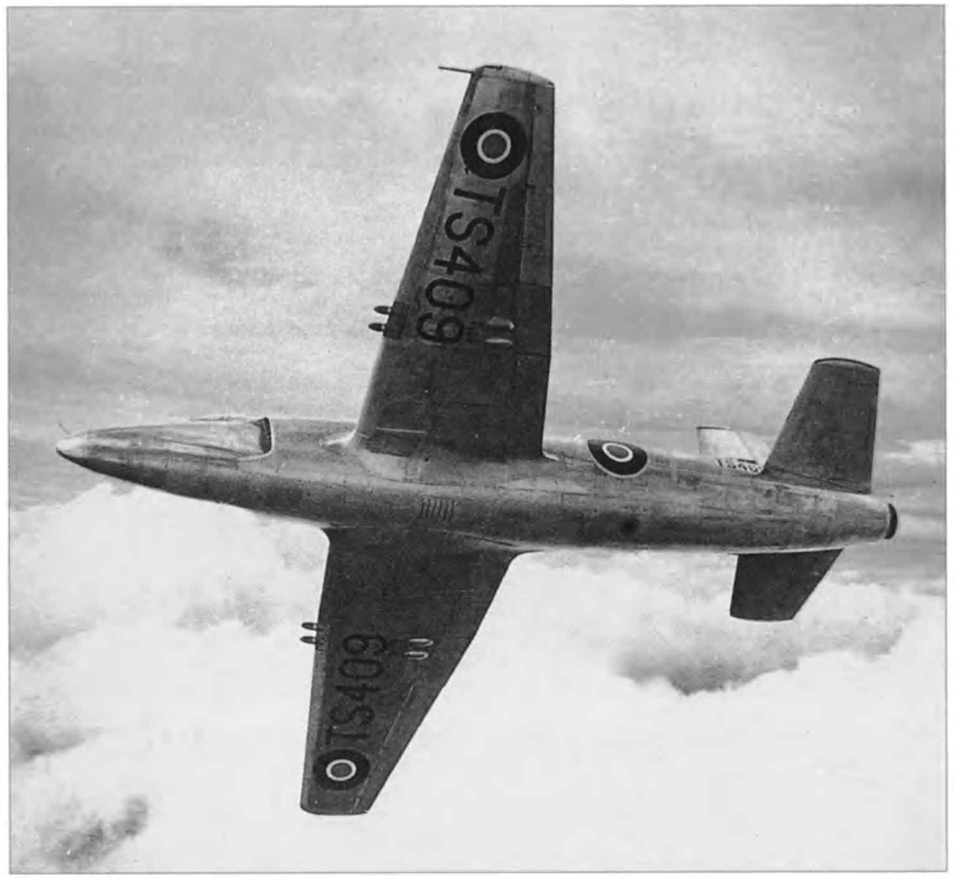




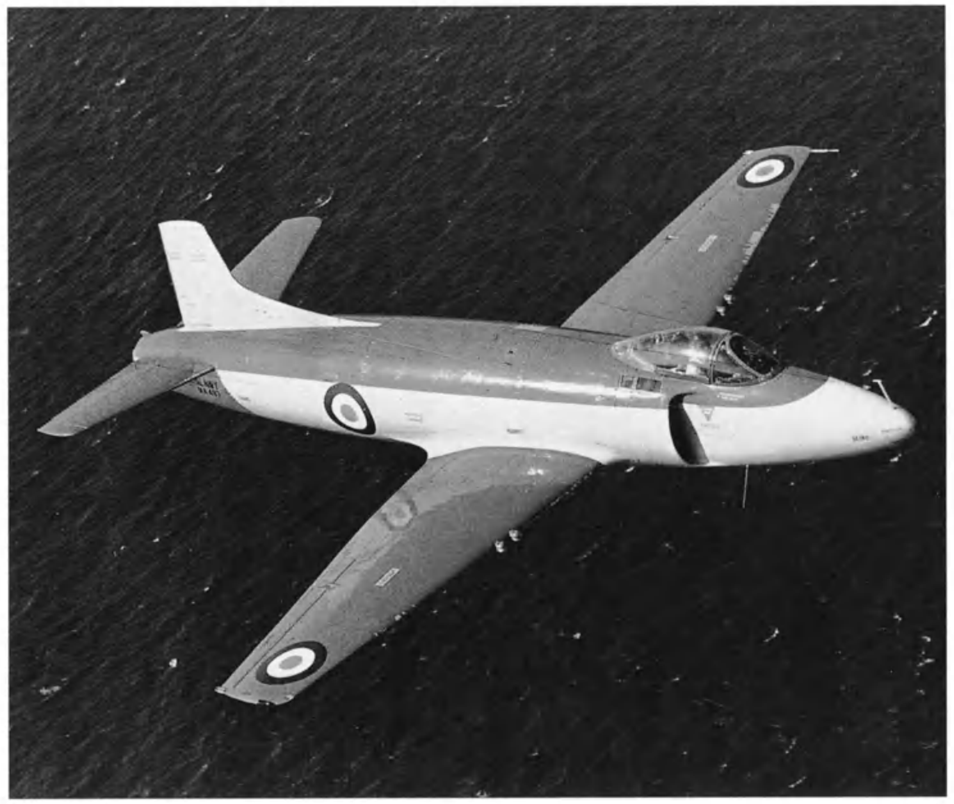
Views of the Saunders-Roe SR.A.1 prototype TG263.

Miles M.52

Mentioned under the Gloster Rocket, the other project discussed at the MAP meeting of 9th October 1943 was a high-speed aircraft and F G Miles of Phillips and Powis was in attendance. In fact the main purpose of this meeting was to initiate action on a very high-speed experimental aeroplane which was to be built by Phillips and Powis and powered by a Whittle W2/700 'with a No.4 augmenter and bypass heating' (that is, reheat). Rough dimensions for the power unit and duct sizes were given to Miles and it was decided that the all-up-weight should be around 5,000lb to 6,000lb (2,268kg to 2,722kg). The target date was nine months hence and the target speed was to be 1,000mph (1,609km/h). Enough fuel was to be provided for a climb to 40,000ft (12,192m) and half an hour's flight at 700mph (1,126km/h), while the aircraft itself was to be a monoplane with a large tailplane that was wholly moving; in other words there were no separate elevators. The use of skids was to be considered instead of an undercarriage. Soon afterwards Phillips and Powis became Miles Aircraft.



The first Supermarine E.10/44 prototype TS409 shows off the wing that was first designed for the piston-powered Spiteful.



Supermarine Attacker F Mk.1 WA497. Eric Morgan

This was the beginning of the supersonic Miles M.52 research aircraft and on 8th November Rowe received the first drawings, the firm calling it the Gyrone Project (Gyrone was the name Whittle intended to use to market his engines at Power Jets). The aircraft was ordered in December and Specification E.24/43 was written around it during mid-1944, but during the next two years progress was much slower than had been hoped for. Eventually the M.52 was cancelled in 1946. (The story of this aircraft is described in depth in the companion volume *British Secret Projects: Jet Fighters since 1950*).

Saunders-Roe SR.A.1

A jet-powered flying boat fighter was first suggested by Saro in a brochure dated 26th July 1943. The SR.44's estimated top speed with de Havilland H.1 engines was 470mph (756km/h) at 20,000ft (6,096m) and 520mph (837km/h) at 40,000ft (12,192m) and sea level rate of climb 4,400ft/min (1,341m/min). On 20th August Liptrot wrote 'the application of jet propulsion to a small boat seaplane fighter would be very attractive since many of the high drag features of the conventional boat are due directly or indirectly to the high engine position which is necessary to give adequate water clearance at the propellers. The N.2/42 [the piston-powered Blackburn B-44 seaplane fighter] produced one solution at the expense of the complication and added weight of the retracting hull bottom. Jets would appear to offer the possibility of a better solution and might give a seaplane little inferior to a landplane designed around the same engines and for the same duty. The main difficulty is providing adequate water clearance at the tail unit.'

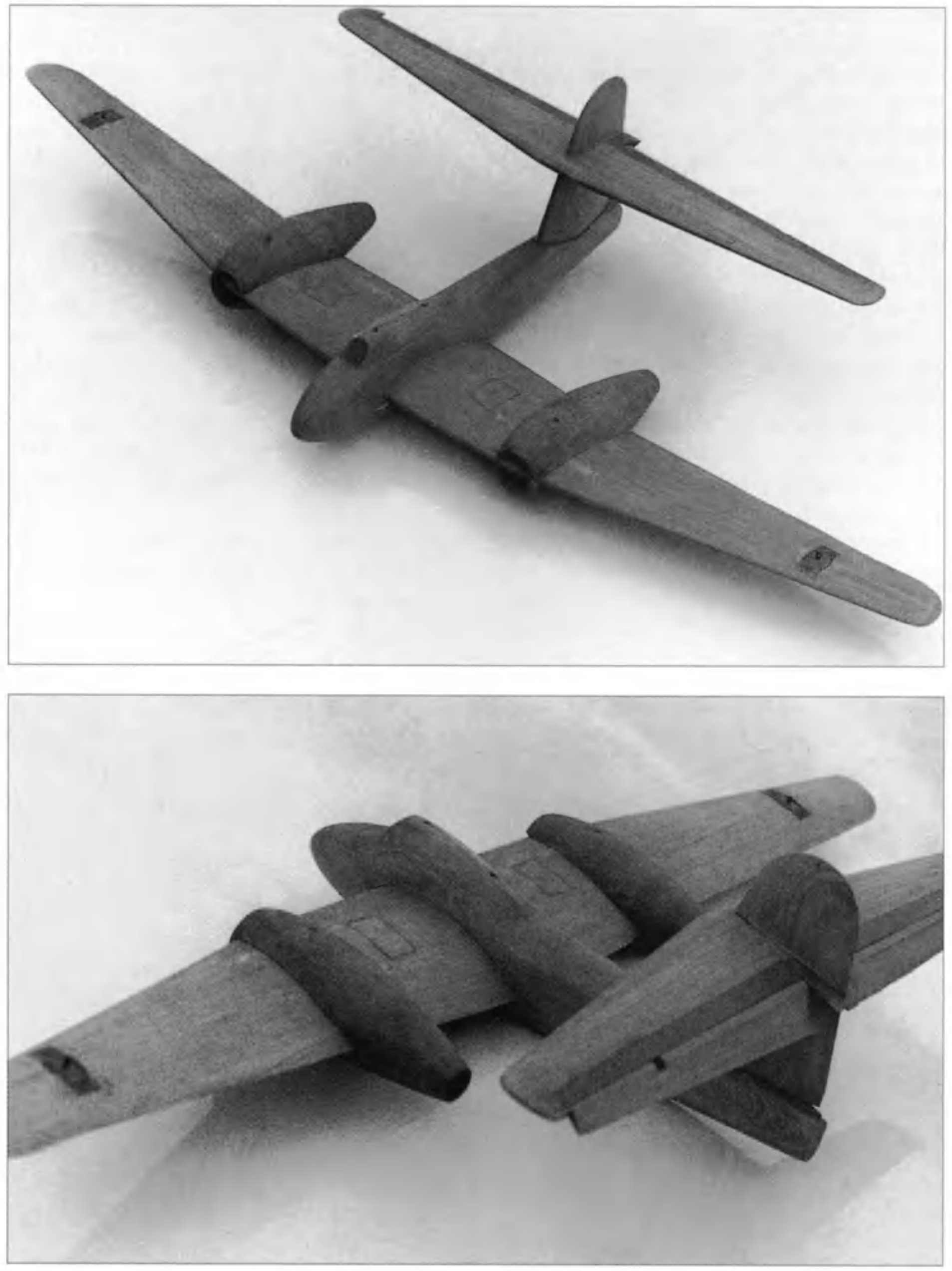
The chief criticism of Saro's first project was that the wing thickness/chord ratio of 15% was too large for a high-speed high-altitude fighter. However, specification E.6/44 was raised in April 1944 to cover a modified project proposed two months earlier. This design was provided with alternative side jet pipes (which were adopted) or twin jet pipes straight back to the tail, span was now 46ft (14.0m), wing area 415ft² (38.6m²) and total weight 14,205lb (6,443kg). Estimated top speed was 505mph (813km/h) at sea level and 506mph (814km/h) at 20,000ft (6,096m), sea level rate of climb 6,800ft/min (2,073m/min). Three prototypes, TG263, TG267 and TG271, were ordered during 1944 and the SR.44 was renumbered SR.A.1 but there was never an Air Staff requirement for such a type. The fighter's minimum drag hull was based on that used by the A.37 Shrimp experimental flying boat of 1939 and to cut down air resistance it featured a refined step design both in plan and elevation; this was thoroughly tested by RAE.

By the close of 1945 the hull structure was nearly complete but, since the war had ended, Saro had become increasingly occupied with the huge SR.45 Princess flying boat, with the result that the schedules for the jet fighter began to slip. The first SR.A.1 finally flew on 7th July 1947 with MetroVick F.2/4 Beryl axial jets but there were to be no production orders. Two of the three prototypes eventually crashed and the survivor completed its flying in 1951.

Supermarine Attacker

At a Future Gas Turbine Aircraft review held on 8th June 1942 it was noted that a scheme from Supermarine, comprising a new fuselage carrying an H.1 engine and fitted with Spitfire wings, was to be discouraged because the company was not in a position to undertake new work. This appears to have been the closest Supermarine ever came to building a 'Jet Spitfire'. Over two years later, on 6th July 1944, Joe Smith completed Supermarine's Type 392 proposal for a Spiteful type wing (Chapter 1) fitted on a special fuselage for jets. This was described as a 'very natural development of the Spiteful' and had one 4,200lb (18.7kN) Rolls-Royce B.41 (Nene), which gave an estimated top speed of 565mph (909km/h) and a rate of climb at sea level of 6,000ft/min (1,829m/min). J D Breakey, ACAS(TR), described the project as 'a very interesting jet propelled fighter proposal which is capable of rapid development', while RAE thought the design was 'quite promising'. Three prototypes, TS409, TS413 and TS416, were quickly ordered and for some time the project was called the 'Jet Spiteful', with 'Jet Seafang' describing a proposed carrier version.

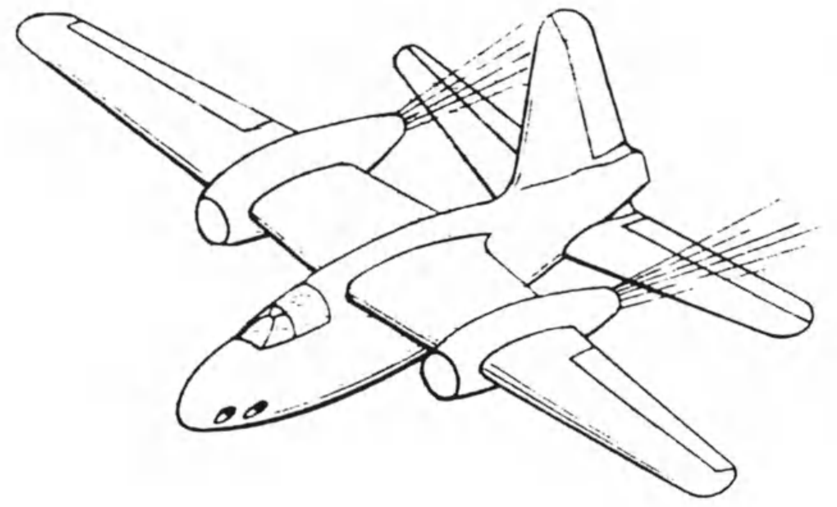
The wing (except for the underwing radiators), undercarriage and gun installation were standard Spiteful components currently entering production on the piston fighter, and the only new parts were to be the fuselage to house the B.41 and the tail unit. Since the fuselage on a new aircraft usually took much less time to design and build than the wings, it was felt that the more difficult half of this project had already been designed and would shortly be in production. The idea behind the proposal was to provide a really practical fighter of the highest possible performance for general service use and provision was made for a pressure cabin, full fighter equipment (including four 20mm guns) and a minimum internal fuel load of 395gals (1,796lit).

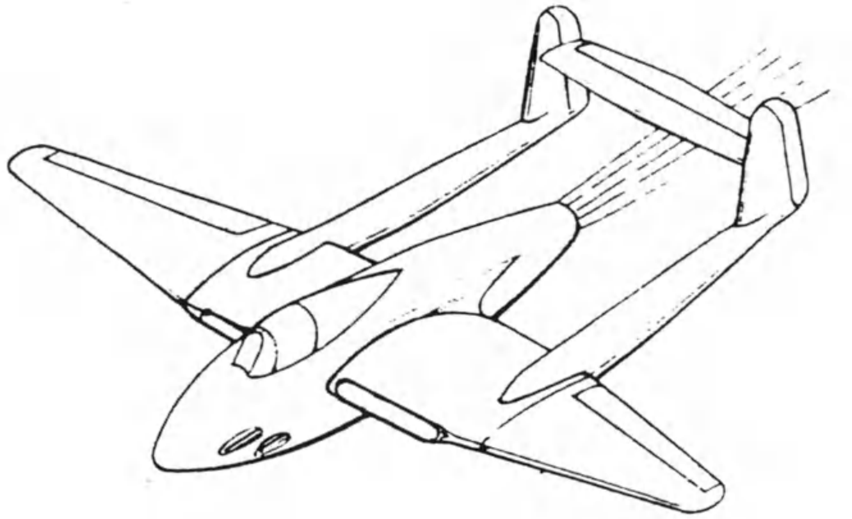


Wind tunnel model of what is believed to be the Westland J.8 Delanne high-altitude fighter of June 1942. Fred Ballam, Westland

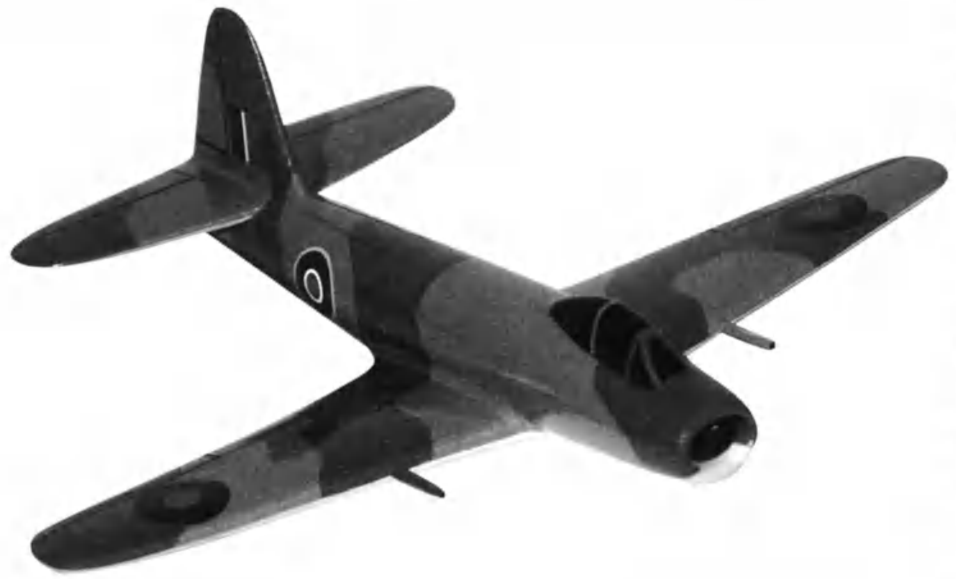
The B.41 was considered to be the ideal engine for this project; initially it would have a static thrust of 3,300lb (14.7kN) but was capable of development to 4,200lb (18.7kN). Rough estimates for the aircraft's performance included (at 3,300lb thrust) a maximum 522mph (840km/h) at sea level and 551mph (887km/h) at 20,000ft, sea level rate of climb 4,390ft/min (1,338m/min), time to 20,000ft 5.65 minutes and service ceiling 46,000ft (14,021m). With 4,200lb thrust these figures became 578mph (930km/h), 571mph (919km/h), 6,100ft/min (1,859m/min), 4 minutes and 51,000ft (15,545m). There was some anxiety that this project should not be 'generally talked about while the present difficult manpower discussions are in progress'.

The Mock-Up Conference was held on 23rd November 1944, after which the Central Fighter Establishment pushed for a nose-wheel undercarriage and the guns to be moved from the wings to the nose (neither was adopted). The following January Supermarine was asked to give its jet fighter 'maximum priority' and to suspend work on its Seagull air-sea rescue amphibian. Specifica-





Rough sketches made in 1945 by Rab Page of Westland of the J.14 Delanne high-altitude fighter and J.15 jet fighter. These are the only known illustrations of these designs.
Fred Ballam, Westland



Information for some of Westland's jet aircraft studies is still lacking and may have been lost for ever. This model, made by Joe Cherrie from reference to some poor quality wartime photos, probably shows a version of the early 1945 fighter designed to exceed 500mph (805km/h).

tion E.10/44 was issued on 6th February 1945 to cover the aircraft and called for a maximum 550mph (885km/h) at all heights up to 30,000ft (9,144m). In July contracts were placed for 24 pre-production aircraft, 6 E.10/44 plus 18 naval variants to Specification E.1/45 (this was cancelled in February 1946 when the Navy switched to 18 Sea Vampires).

On 3rd February 1945 a member of the Naval Staff wrote 'the operation of this aircraft will present the RAF with no new problems. On the other hand, this is the first jet aircraft to be tried in the Navy and we shall be presented with a number of new and serious problems to solve. A comprehensive series of deck trials will have to be provided for'. The first prototype made its maiden flight on 27th July 1946 but the type was never adopted by the RAF. However, the second and third prototypes became known as 'E.10/44 Hooked Jet Spitefuls' and, after much deliberation, the aircraft did enter service with the Royal Navy as the Attacker. It was the Navy's first jet fighter but was not a great success.

Westland Jet Fighters

In January 1941 the first technical contact was made between Westland and Power Jets, when details of the engine were revealed to the aircraft company. There was an immediate proposal by Westland to try two 1,800lb (8.0kN) thrust Whittle W2B engines in its Whirlwind piston fighter but this project was subsequently abandoned (estimated all-up-weight was 10,000lb [4,536kg], span 45ft [13.7m], wing area 250ft^2 [23.3m^2] and maximum speed 420mph [676km/h] at 30,000ft).

Another early jet fighter project from W E W Petter, Westland's designer, was a long span Delanne tandem-wing type with a high 'tail' proposed in June 1942 . It is understood that this was to be a competitor to the high-altitude long-span Meteor; no reports survive but the project was apparently tunnel tested in November and December 1942. Its wing owed much to the Welkin high-altitude piston fighter (Chapter 2) and this project was in the tunnel just a few days after the Welkin's maiden flight. In fact it was designed to the Welkin specification F.4/40 and was powered by two Whittle W2B/700 units; span was 60ft (18.3m), main wing area 380ft^2 (35.3m^2), Delanne wing area 180ft^2 (16.7m^2), all-up-weight 16,500lb (7,484kg) and estimated top speed 420mph (676km/h). Known as the J.8, it was later abandoned.

By the time of the Jet Aircraft review of 8th June 1942 mentioned under the Attacker, Petter was trying a Delanne high-altitude fighter scheme called the J.14 which had a low position 'tail' – the version with a high position surface, though offering sufficient stability, had produced too much drag and was structurally uneconomical (Note: if this refers to the J.8, the official document conflicts with Westland sources). The new design used two 3,000lb (13.3kN) H.1s, spanned 51ft (15.5m), wing area was 290ft^2 (27.0m^2), all-up-weight 13,000lb (5,897kg), maximum speed 480mph (772km/h) at 40,000ft (12,192m) and operational ceiling 52,000ft (15,850m); four guns were mounted in the lower nose. This too was abandoned.

Next, the J.15 was begun in October 1942 and closely resembled the DH.100 with a twin-boom configuration, short jet pipe and four nose guns; there is strong evidence to suggest that it was prepared to Specification E.5/42. In May 1943 a heavier navalised version was proposed to Specification N.7/43 (Chapter 10), but neither was built. Finally a study was made in January 1945 for a straight-wing fighter designed to exceed 500mph (805km/h) that looked similar to the Supermarine Attacker but with a nose intake.

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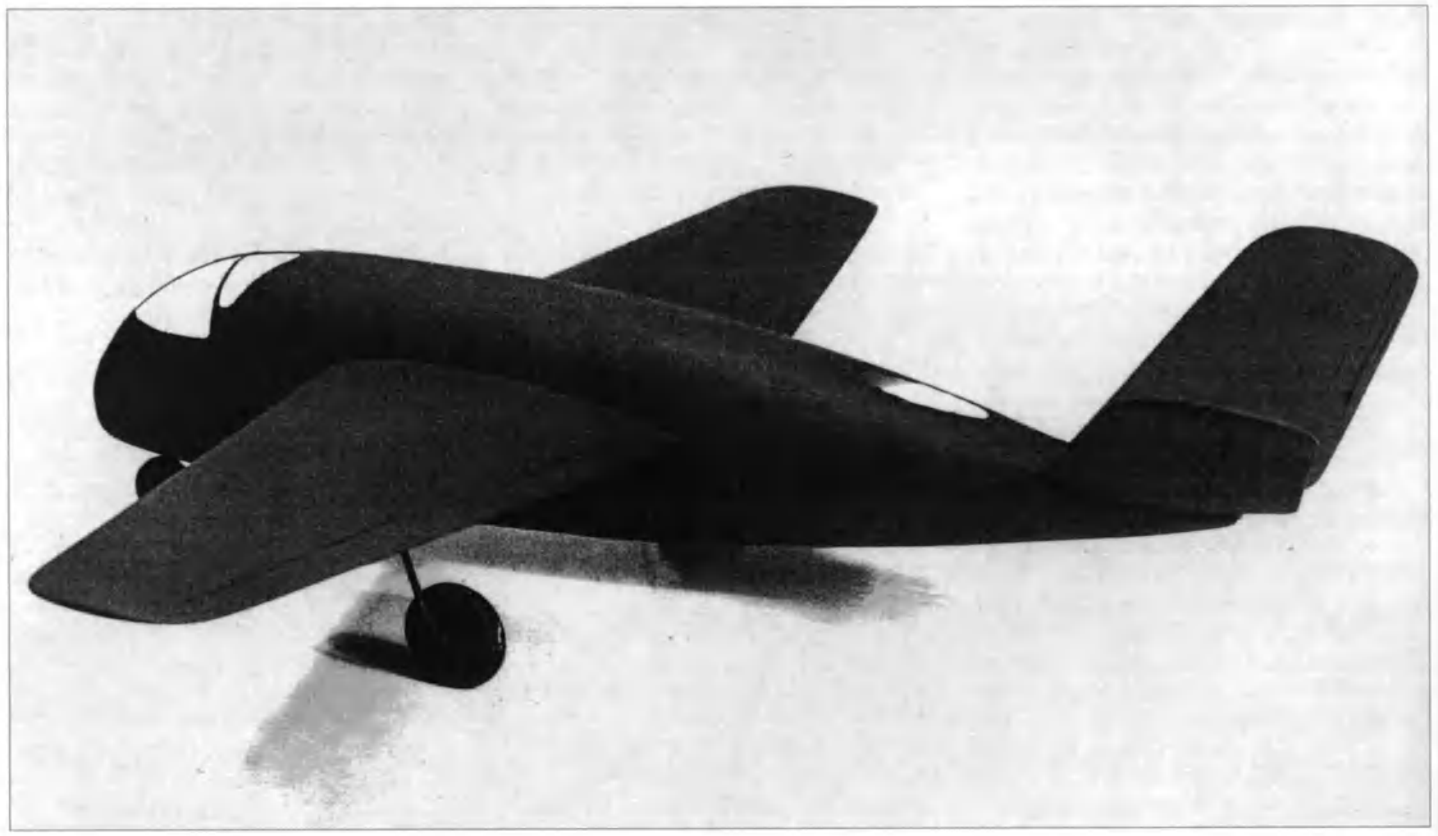
The development of the jet is a great story but it must have been something of a shock to many in the industry. The earlier chapters have described what were in fact to be the last major developments in piston combat aircraft and types like the Sea Fury and Hornet represent the zenith of piston fighter design. They had immensely powerful and complex engines and, due to the limits of the 'Sound Barrier', gave just about the maximum performance that could ever be expected from their form of propulsion. Then along comes this chap Whittle who, with a relatively crude jet engine stuffed into a very basic airframe (the Meteor), produced a performance that nearly matched the 'ultimate' piston fighters; in fact after the war the Meteor regained the World Air Speed Record for Britain. There were many problems to solve of course – for example the early jets guzzled fuel at a rapid rate – but when all of this sank in the realisation of the near limitless potential of the jet must have been astonishing.

Jet Fighters – Estimated Data

Project	*Span ft in (m)*	*Length ft in (m)*	*Gross Wing Area ft^2 (m^2)*	*Max Weight lb (kg)*	*Engine hp (kW)*	*Max Speed / Height mph (km/h) / ft (m)*	*Armament*
Gloster 'Scheme 1'	27 0 (8.2)	23 6 (7.2)	127 (11.8)	2,800 (1,270)	1 x Whittle engine	460 (740) at 30,000 (9,144)	None fitted
Gloster 'Scheme 2'	27 0 (8.2)	26 6 (8.1)	127 (11.8)	2,800 (1,270)	1 x Whittle engine	460 (740) at 30,000 (9,144)	Nose gun on drawing
Gloster E.28/39	29 0 (8.8)	25 4 (7.7)	146.5 (13.6)	3,700 (1,678)	1 x W1 860 (3.8)	339 (545) at 20,000 (6,096)	None fitted
Gloster F.9/40 (early 1941)	43 0 (13.1)	41 3 (12.6)	374 (34.8)	10,650 (4,831) 4 cannon 11,020 (4,999) 6 cannon	2 x Whittle W2B 1,640 (7.3)	440 (708) at 30,000 (9,144)	4 or 6 x 20mm cannon
Gloster Meteor 'Mk.2' (November 1942)	44 4 (13.5)	41 4 (12.6)	387 (36.0)	13,300 (6,033)	2 x H.1 2,500 (11.1)	490 (788) at 30,000 (9,144)	4 x 20mm cannon
Gloster Meteor F Mk.1 (flown)	43 0 (13.1)	41 5 (12.6)	374 (34.8)	11,775 (5,341)	2 x W2B/23 1,600 (7.1)	446 (718) at 30,000 (9,144)	4 x 20mm cannon
Gloster Rocket	38 0 (11.6)	32 3 (9.8)	225 (20.9)	9,000 (4,082)	2 x B.37 2,200 (9.8)	550 (885) at 30,000 (9,144)	4 x 20mm cannon
Gloster E.1/44 Ace (flown) * = TX148	36 0 (11.0)	38 0 (11.6) 38 11 (11.9)*	266 (24.7)	11,470 (5,203)	1 x Nene RN.2 5,000 (22.2)	633 (1,019) at sea level	4 x 20mm cannon plus bombs or RPs
AWA Meteor NF Mk.11	43 0 (13.1)	48 6 (14.8)	374 (34.8)	16,542 (7,503)	2 x Derwent 8 3,700 (16.4)	580 (933) at sea level	4 x 20mm cannon
de Havilland DH.99 (6 June 1941)	40 0 (12.2)	31 0 (9.5)	260 (24.2)	7,970 (3,615)	1 x H.1 2,900 (12.9)	493 (793) at 35,000 (10,668) (2,700lb [12.0kN] thrust)	4 x 20mm cannon
de Havilland Vampire F Mk.1 (flown)	40 0 (12.2)	30 9 (9.4)	266 (24.7)	10,480 (4,754)	1 x Goblin 1 3,100 (13.8)	540 (869)	4 x 20mm cannon
de Havilland Venom FB Mk.1 (flown)	41 8 (12.7)	31 10 (9.7)	280 (26.0)	15,400 (6,985)	1 x Ghost 103 4,850 (21.6)	640 (1,030)	4 x 20mm cannon, plus 2,000lb (907kg) bombs or RPs
Hawker Sea Hawk F Mk.1 (flown)	39 0 (11.9)	40 0 (12.2)	278 (25.8)	13,200 (5,988)	1 x Nene 101 5,000 (22.2)	591 (951) at sea level	4 x 20mm cannon
Saunders-Roe SR.44 (26 July 1943)	40 0 (12.2)	35 0 (10.7)	270 (25.1)	7,710 (3,497)	2 x H.1(?)	520 (837) at 40,000 (12,192)	?
Saunders-Roe SR.A.1 (flown)	46 0 (14.0)	50 0 (15.2)	415 (38.6)	16,255 (7,373)	2 x Beryl MV.B.1 3,250 (14.4)	516 (830)	4 x 20mm cannon plus bombs (never carried)
Supermarine Attacker F Mk.1 (flown)	36 11 (11.2)	37 6 (11.4)	226 (21.0)	11,500 (5,216)	1 x Nene 3 5,100 (22.7)	590 (949) at sea level	4 x 20mm cannon
Westland J.15	46 0 (14.0)	?	240 (22.3)	9,600 (4,355)	1 x H.1 3,000 (13.3)	490 (788) at 35,000 (10,668)	4 x 20mm cannon

Chapter Twelve

Jet Bombers



Although the great majority of early British jet aircraft design was devoted to fighters it was not long before proposals followed for bombers powered by jet engines. The Ministry's 8th June 1942 'Future Gas Turbine Aircraft Projects' review actually listed four bomber designs:

1. A Gloster proposal with four 1,700lb (7.6kN) W2B engines, 31,000lb (14,062kg) all-up-weight, 4,000lb (1,814kg) bomb load, 440mph (708km/h) top speed at 40,000ft (12,192m) and 1,500 miles (2,414km) range.
2. The same aircraft with 4,500lb (2,041kg) bombs giving a 35,000lb (15,876kg) all-up-weight and 1,350 miles (2,172km) range.
3. A de Havilland proposal with two 3,000lb (13.3kN) H.1s, 22,000lb (9,979kg) all-up-weight, 2,000lb (907kg) bombs, 445mph (716km/h) maximum at 40,000ft and 1,500 miles range.
4. An RAE tail-first proposal with two 4,000lb (17.8kN) F.3 engines, 30,000lb (13,608kg) all-up-weight, 4,000lb of bombs, 435mph (700km/h) top speed at 40,000ft and 2,100 miles (3,379km/h) range.

It was agreed that, at the present time, the obvious engine choices for bomber types were the F.3 and H.1.

In terms of bomber schemes the Review concluded that:

1. Although engines were not yet sufficiently developed, they were within striking distance and it was now time to start a bomber design to come to fruition with the engines in two years time.
2. Although a conventional type of gas turbine bomber could be built the CofG position would be sensitive to changes in load distribution and rear armament would probably upset the balance.
3. Therefore an attempt should be made on 'the optimum design which appears to be the unconventional tail-first type'.

The conventional unarmed bomber would be at the mercy of jet fighters but it could be built if the Air Staff wanted a jet-powered bomber quickly.

Gloster Jet Bombers

Gloster Jet Bomber

Probably the first ever British design for a jet bomber was a brochure completed by Gloster on 12th August 1941 which showed a machine powered by four 2,000lb (8.9kN) Whittle W2Bs and each unit in its own individual wing-mounted nacelle sufficiently outboard of the wing centre section to avoid interference. George Carter explained that the proposal took the development of the jet beyond the Gloster fighter but this was not a finalised scheme. Two crew were carried, there was no provision for defensive armament and the nosewheel of the tricycle undercarriage was a problem to the design of the front fuselage. The project was regarded as a rational development of the F.9/40 with the same basic layout; its range was 1,500 miles (2,414km) plus twenty minutes over the target, ceiling 55,300ft (16,855m) and internal fuel 1,225gals (5,570lit).

Gloster P.109

In December Carter completed a revised study (drawing P.109 dated 24th November) with the same powerplant but with the power units now closely coupled in a common nacelle; this also provided a suitable housing for the fore and aft retracting undercarriage. The units were mounted ahead of a single-spar structural member and the exhaust pipes passed through elongated apertures at the rear of the nacelle. This arrangement, with a common entry and exit, was regarded as the most efficient installation for a pair of jet engines. Carter felt the design was perhaps the best that could presently be done with four W2Bs (the possibility of six engines was being considered with the all-up-weight increased to 41,000lb [18,598kg]).

The main design conditions were substantially the same as the earlier project but the normal bomb load was now 4,500lb (2,041kg) (range 1,750 miles [2,816km]) and maximum 6,000lb (2,722kg) (range 1,500 miles [2,414km]); the bomb load could comprise six 1,000lb (454kg) or nine 500lb (227kg). Outward cruise speed would be 395mph (636km/h) at 40,000ft (12,192m), over the target 405mph (652km/h) and the time needed to get to 40,000ft was 40 minutes. Carter concluded that the main purpose of the proposal was to outline the general suitability of jet propulsion units for a bomber type and more particularly to indicate the practicability of a scheme using four standard W2Bs.

On 6th February 1942 Capt Liptrot completed his appraisal for N E Rowe and declared that Gloster had underestimated the service load by some 700lb (318kg) and the structure by 300lb (136kg) – he expected the total weight to be 35,500lb (16,103kg), the cruise speeds to be about 25mph (40km/h) lower and maximum range 1,350 miles (2,172km). In addition the mean thrust needed to be increased by some 2,500lb (11.1kN) during a take-off to cut down the take-off distance and his main objection was the use of Whittle power units. The new Halford engine would be far more appropriate to this type, not only by virtue of its better static thrust which would tend to satisfy the take-off situation, but also by its better cruising conditions. Liptrot added that the analysis showed that it was perfectly feasible, even now, to undertake the design of a pressure cabin unarmed bomber comparable, so far as bomb load and range were concerned, with the Hawker P.1005 (Chapter 5).

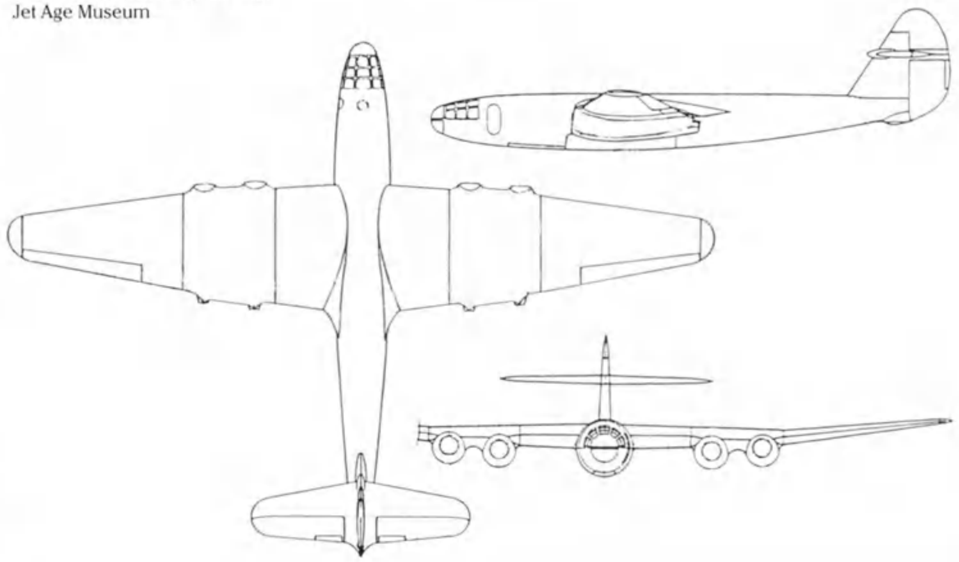
The same day Rowe wrote to CRD noting that 'these proposals were not sent by Carter with any idea that we would adopt them. You can take this scheme as an idea of a "practical design" – an explanation of how the W2B could be used in a bomber. The conclusion from this work is that the power/weight ratio and fuel consumption of the unit are not good enough for the maximum range we require from bombers nowadays. If the Halford engine comes up to promise, there is little doubt that we shall be able to put it into a bomber type with upwards of 2,000 miles (3,218km) range'. CRD replied three weeks later 'Once we've got a 3,000lb (13.3kN) thrust engine, the bomber projects begin to get attractive'. He also stated that the 'day of the jet bomber may not be yet but I do not want such projects pushed into the background'. On 10th April however, Rowe stated that he felt the promise of suitable jet engines for powering medium-range bombers of 1,600 miles (2,547km) was still not strong enough and the best course now was to go forward with the jet fighter.

De Havilland Jet Bomber

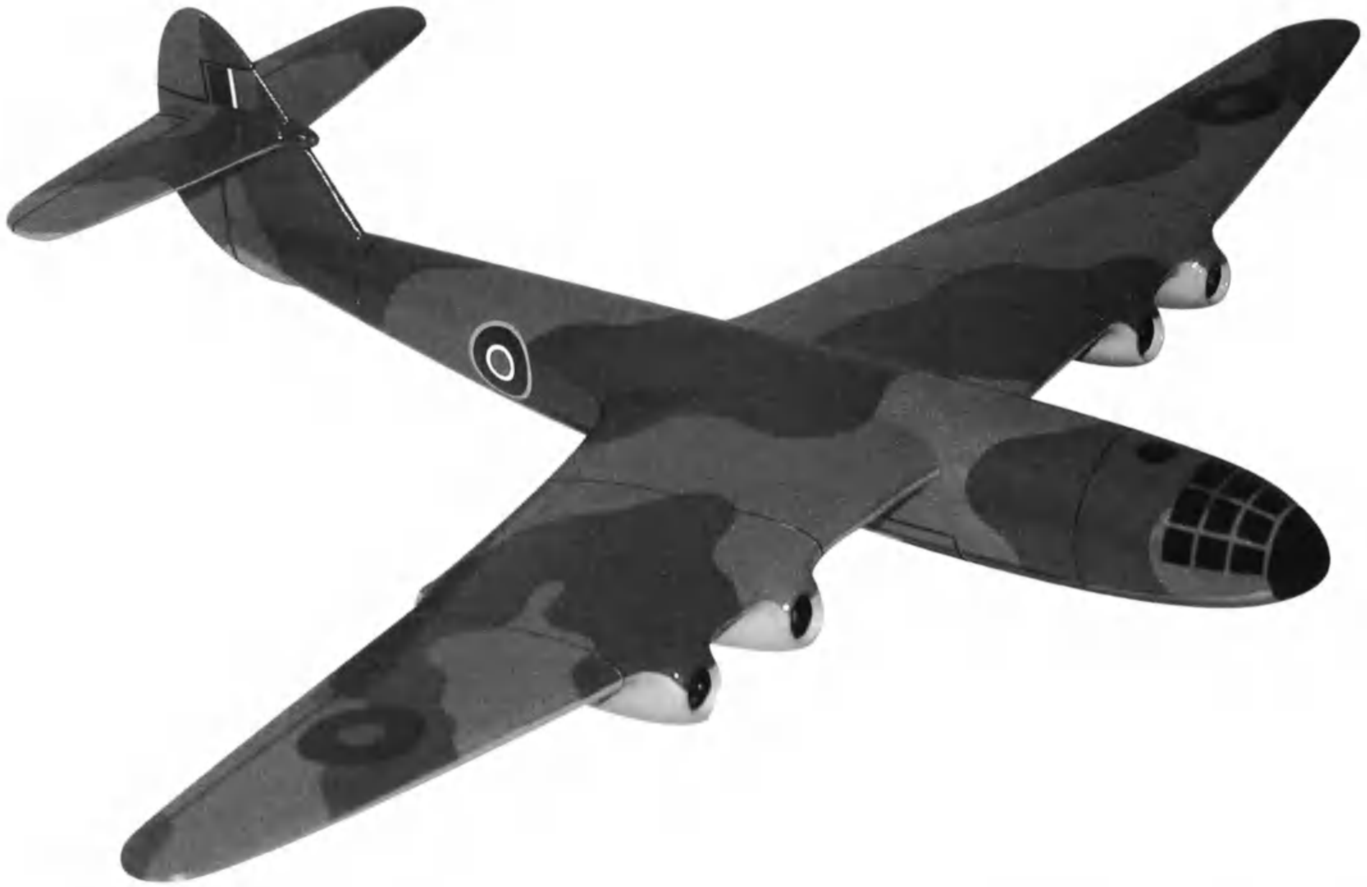
It is unknown just how much work de Havilland put into the design of a jet bomber but in February 1942 the company was asked to examine the question of designing a twin-jet bomber instead of the single jet fighter on which it was engaged (the DH.100). As noted in Chapter 11, de Havilland's C C Walker told Rowe on 13th February that the case for proceeding with the fighter was as strong as it was before. He added that 'so far as the design of a jet-propelled bomber is concerned, this most interesting proposal depends on everything coming out exactly according to plan, and while there is no reason to doubt that the expected figures will eventually be obtained, we should have to wait until the altitude power and other features had been substantiated before starting it'.

There was also the domestic side of the question. De Havilland had had the greatest difficulty in getting enough design capacity to do the new DH.102 bomber (Chapter 5), to look after Mosquito development and production, and to do the new jet fighter. By making special arrangements with the Airspeed company it had been able to do this but if de Havilland was to try to substitute a twin-jet bomber for the fighter in its design programme, it (being a much bigger job) would put the programme definitely out of the com-

Opposite page: **An alternative idea by Petter of Westland for a jet-powered fighter bomber (c.3.44). There appears to have been two versions, each having two engines. The first had side-by-side units, side intakes and jet pipes designed along the lines of the Hawker P.1040, plus a conventional fin and tail. The second (shown here) a nose intake, engines stacked one above the other and an outlet in the upper fuselage which required a V-tail. These were quite large aeroplanes.**
Fred Ballam, Westland



Gloster Jet Bomber (12.8.41).
Jet Age Museum



Models of the first version of the Gloster Jet Bomber with engines mounted in individual nacelles.

pany's reach. Walker hoped that, for all these reasons, de Havilland could go straight ahead with the fighter.

It due course it did, although Walker added a postscript on 23rd February – 'We do fully realise the importance of producing a bomber with twin H.1 units when they have shown that they can deliver the anticipated thrust/consumption. So far as our capacity to produce is concerned, if we were engaged on the fighter, the Sabre bomber and Mosquito development, we could do no more. There is, however, this further possibility. If the H.1 soon shows that it can do what is expected, we could do the H.1 bomber instead of the Sabre bomber. It would do the same job with a higher performance and would only be subject to the duration-at-low-altitude limitations we have indicated. Much of the work we have done on the Sabre version would be of use in such a design, and two could be produced for the same production effort as one Sabre machine. The problem of getting a Sabre machine into production with its counter-rotating propellers – new installation and equipment problems with the skilled labour position as it is, is one which makes us look rather hungrily at the much simpler H.1 version. Substituting the H.1 bomber for the Sabre bomber is one of the possible alterations to be considered.'

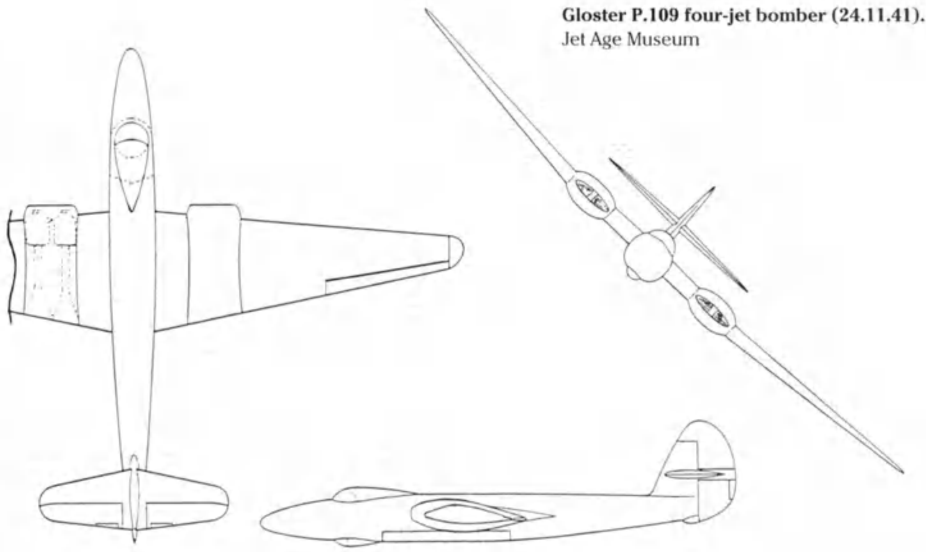
How long the de Havilland jet bomber design lasted is unknown but the June 1942 Jet Projects Review noted a proposal with two 3,000lb (13.3kN) H.1s, 22,000lb (9,979kg) all-up-weight, 2,000lb (907kg) bomb load, top speed 445mph (716km/h) at 40,000ft (12,192m) and a range of 1,500 miles (2,414km). No project number was allocated but a drawing has been found for a 'Jet Mosquito'.

Westland P.1056

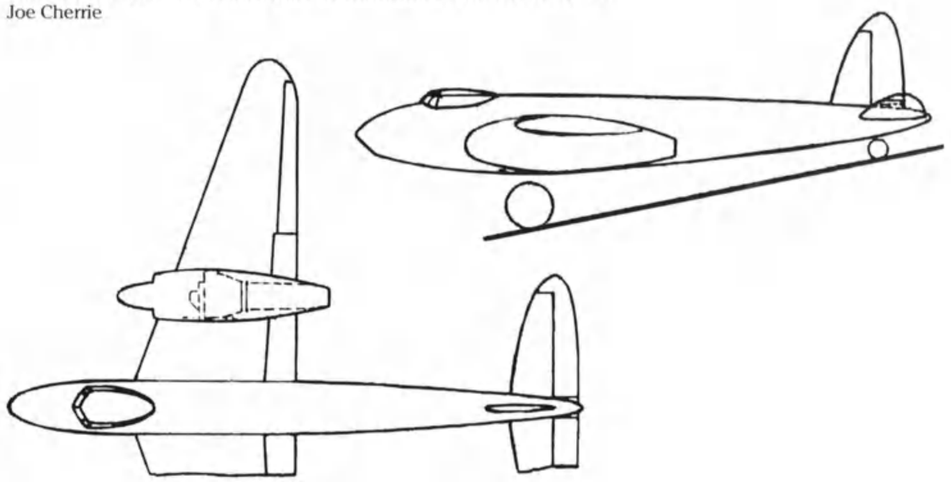
In early 1944 Westland's technical director W E W Petter, after discussions between his company and two members of MAP, Sir Wilfred Freeman and N E Rowe, completed a design study for a high-speed twin jet-powered fighter bomber called the P.1056. Petter sent off his first drawings on 1st February and suggested a big mix of weapons – two, four or six 20mm cannon (mounted beneath the nose intake), two six pounder guns, nine 500lb (227kg), three 1,000lb (454kg) or two 2,000lb (907kg) bombs in a lower fuselage internal bomb bay, or 90lb (41kg) rocket projectiles. Various mixes of guns and bombs were listed together with their effect on range – six 20mm alone gave a range of 1,375 miles (2,212km) but a large bomb load plus alternative gun arrangements reduced this to 790 miles (1,271km).

Initially the P.1056 had the tailwheel arrangement used by most piston aircraft but later a tricycle undercarriage with a nosewheel was introduced (published sources state this version was called P.1061). Power was supplied by a pair of MetroVick F.2/4 Beryl axial jets mounted side-by-side in the centre fuselage and fed by a large nose intake. To avoid the tailwheel the exhaust was ejected through holes in the side of the fuselage ahead of the tailplane, but introducing the tricycle gear meant a more effective single pipe at the very end of the fuselage could be fitted to serve both engines. The two crew sat side-by-side.

On 20th February J D Breakey wrote 'we have found it difficult to associate this project with the fighter/bomber role as we understand it. Petter has obviously intended this aircraft to be a ground attack close-support weapon as he calculates his range on a basis of 250 miles (402km) at ground level and provides for protection from forward and ground fire. For the fighter/bomber we require a highly manoeuvrable aircraft which will not be required to operate above 10,000ft (3,048m) and I find it difficult to believe that the jet reaction type of power unit is the most suitable for such an aircraft. With any of Petter's proposals we get an aircraft which has to go over 20,000ft (6,096m) to obtain reasonably economic cruising conditions for the range requirement and has a poor take-off of 1,500 yards (1,373m) to 50ft (15m) [altitude], which is very undesirable in an aircraft which might be expected to operate from improvised airfields. I also find it difficult to reconcile the size of the twin MetroVick F2 Mk.4 aircraft with the manoeuvrability required in the fighter/bomber role.'



Gloster P.109 four-jet bomber (24.11.41).
Jet Age Museum

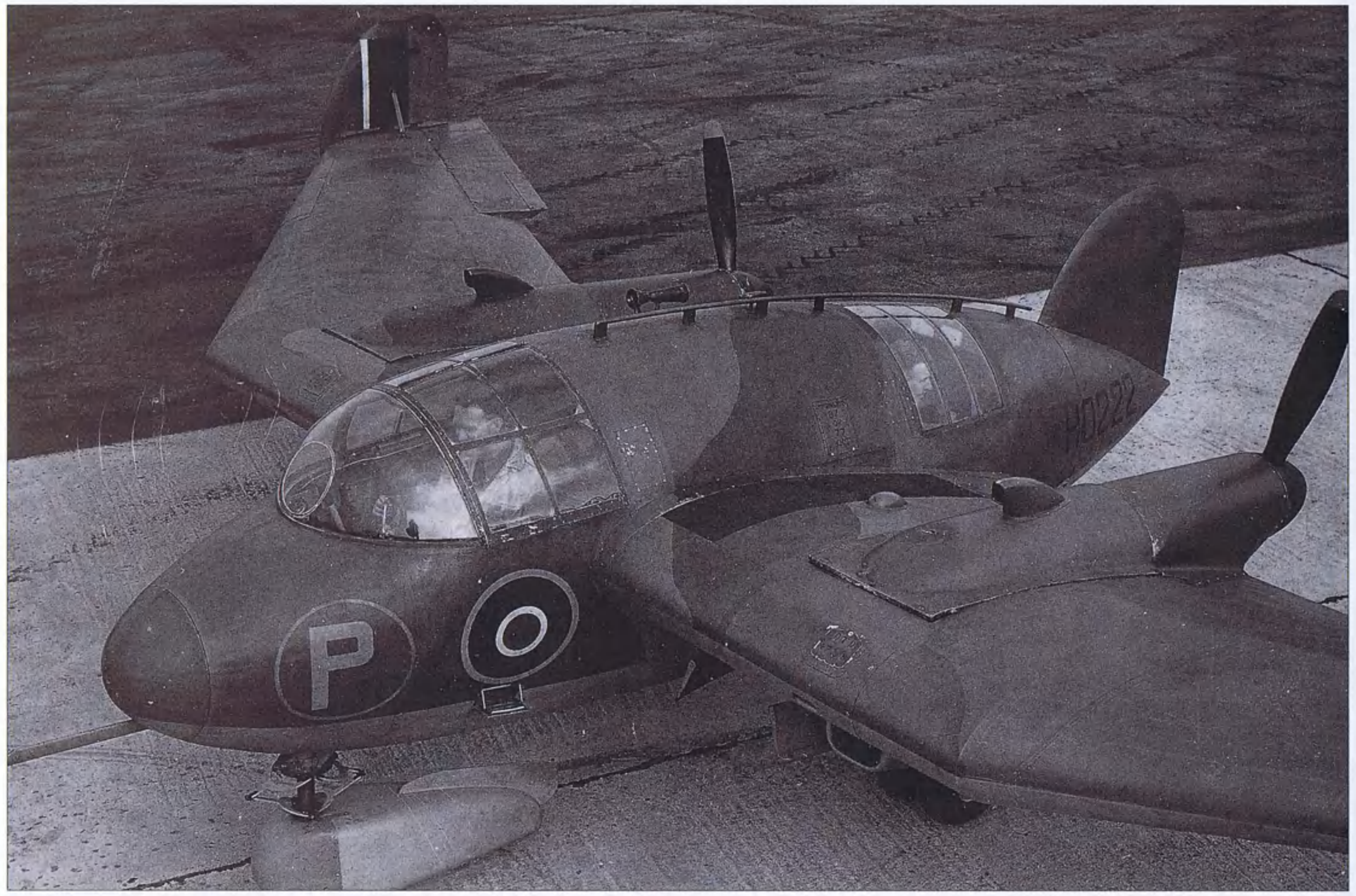


This 'Jet Mosquito' is probably the de Havilland Jet Bomber of 1942.
Joe Cherrie

However, Breakey had recently discussed the project with Petter and found that the design lent itself to a very much more flexible bomber arrangement than was suggested in the brochure, with a maximum capacity of 4,500lb (2,041kg) bombs, and he could foresee a better future for something of this sort as a high-speed bomber. He suggested that the whole project should be re-examined on these lines and in this idea he was correct because the concept was eventually to became the post-war Canberra flown in 1949, although built by English Electric (whom Petter had joined) and not Westland. In May 1944 Breakey wrote 'the scheme offered in the twin MetroVick form is attractive and I should like to see it put in hand'. A mock-up of the nose and central fuselage was constructed while Petter displayed a scale model on his desk complete with bombs, engines and internal fittings, but this particular design was never built.

Handley Page Research

Before the war ended there were several other proposals for jet-powered combat aircraft, including the 'giant' jet bomber from Handley Page listed in Chapter 7 and several jet conversions of piston types like the Mosquito above and the 'Jet Sturgeon' in Chapter 9, but details for most are very sketchy. By late December 1942 agreement had been reached to put in hand an 'experimental design' of jet bomber of 40,000lb to 50,000lb (18,144kg to 22,680kg) all-up-weight and Handley Page had been selected to do this project which was essentially expected to take the form of a tailless aircraft. At the time



The sole Handley Page HP.75 Manx tailless research aircraft received Class B serial H0222. Ray Sturtivant

Handley Page was the only company with a current active interest in tailless aeroplanes (although Armstrong Whitworth had made a paper study of the problems of tailless bombers with jet propulsion) and it had a small twin-engined model ready for flight (the Manx which actually did not fly until 25th June 1943). The Ministry felt that the company should be ready to get down to design work by about April 1943, although this depended on its Halifax workload, but the project appears never to have got going.

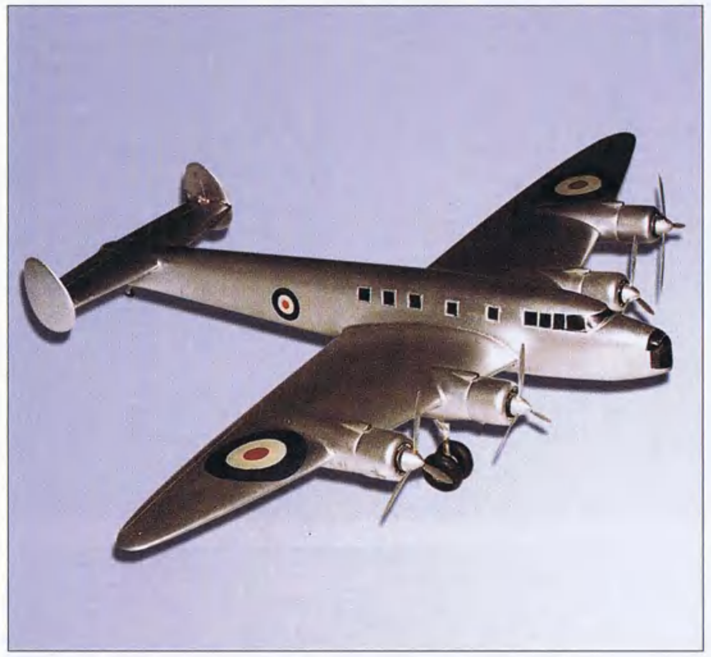
Bristol 'Jet Buckingham'

Some references have been found in official documents for a 'Jet Buckingham'. The first suggestions for fitting jets in combination with normal piston engines, which would turn the Buckingham into a very high-speed bomber, were made in September 1941. The jets would be fitted in the rear half of the nacelles behind the piston units and give, for short periods only, an increment of speed at full throttle at moderately low altitudes. It was indicated that at 15,000ft (4,572m), from the piston only maximum of 340mph (547km/h), this increase could perhaps reach 430mph (692km/h) with Rolls-Royce engines and 407mph (655km/h) with Whittle units; at 20,000ft (6,096m) the new figures from an original 368mph (592km/h) would be 450mph (724km/h) and 430mph respectively. However, on 17th January 1942 N E Rowe noted that they 'do not propose to add this to Bristol's burden at the moment but would like details worked out as soon as the way is clear'. The 'Jet Buckingham' was another project to eventually fall by the wayside.

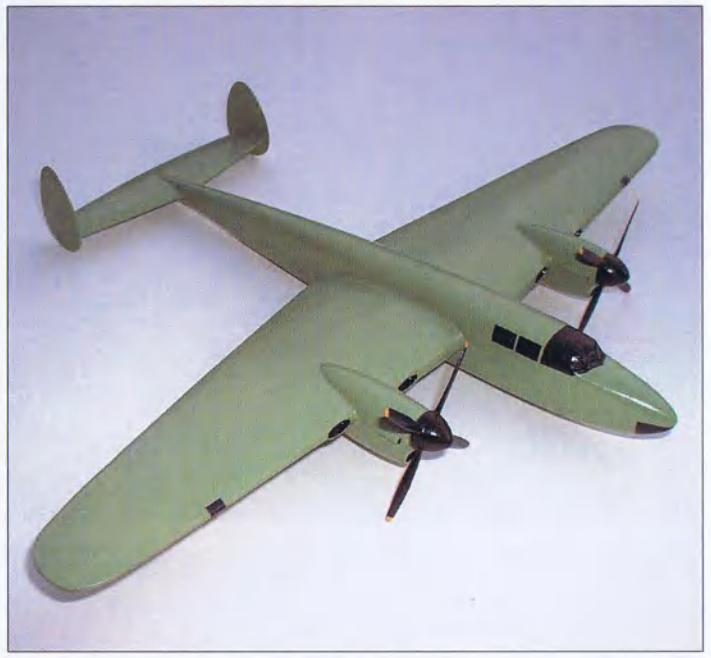
Jet Bombers – Estimated Data

Project	*Span ft in (m)*	*Length ft in (m)*	*Gross Wing Area ft² (m²)*	*Max Weight lb (kg)*	*Engine hp (kW)*	*Max Speed / Height mph (km/h) / ft (m)*	*Armament*
Gloster Jet Bomber (12 August 1941)	84 0 (25.6)	62 6 (19.1)	900 (83.7)	31,500 (14,288)	4 x W2B 2,000 (8.9)	454 (730) at 36,000 (10,973)	4,000lb bombs normal load, 8,000lb (3,629kg) overload
Gloster P.109 (24 November 1941)	100 0 (30.5)	72 0 (21.9)	1,120 (104.2)	34,500 (15,649) norm 36,000 (16,330) o'load	4 x W2B 2,000 (8.9)	?	4,500lb bombs normal load, 6,000lb (2,772kg) overload
Westland P.1056	56 6 (17.2)	?	550 (51.2)	32,000 (14,515)	2 x F.2/4 Beryl 3,500 (15.6)	520 (837) at 25,000 (7,620)	See Text.

British Secret Fighter & Bomber Colour Chronology

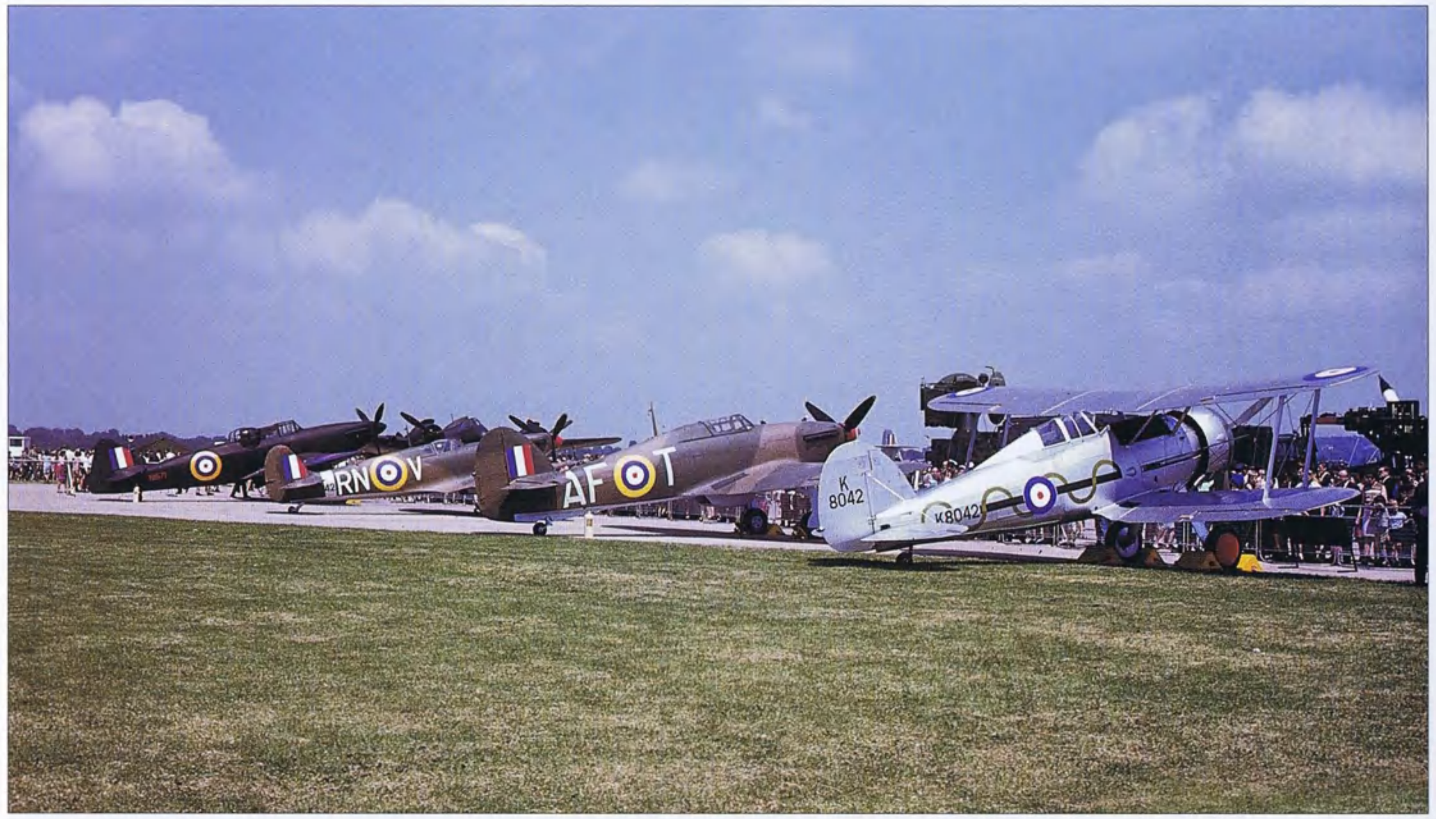


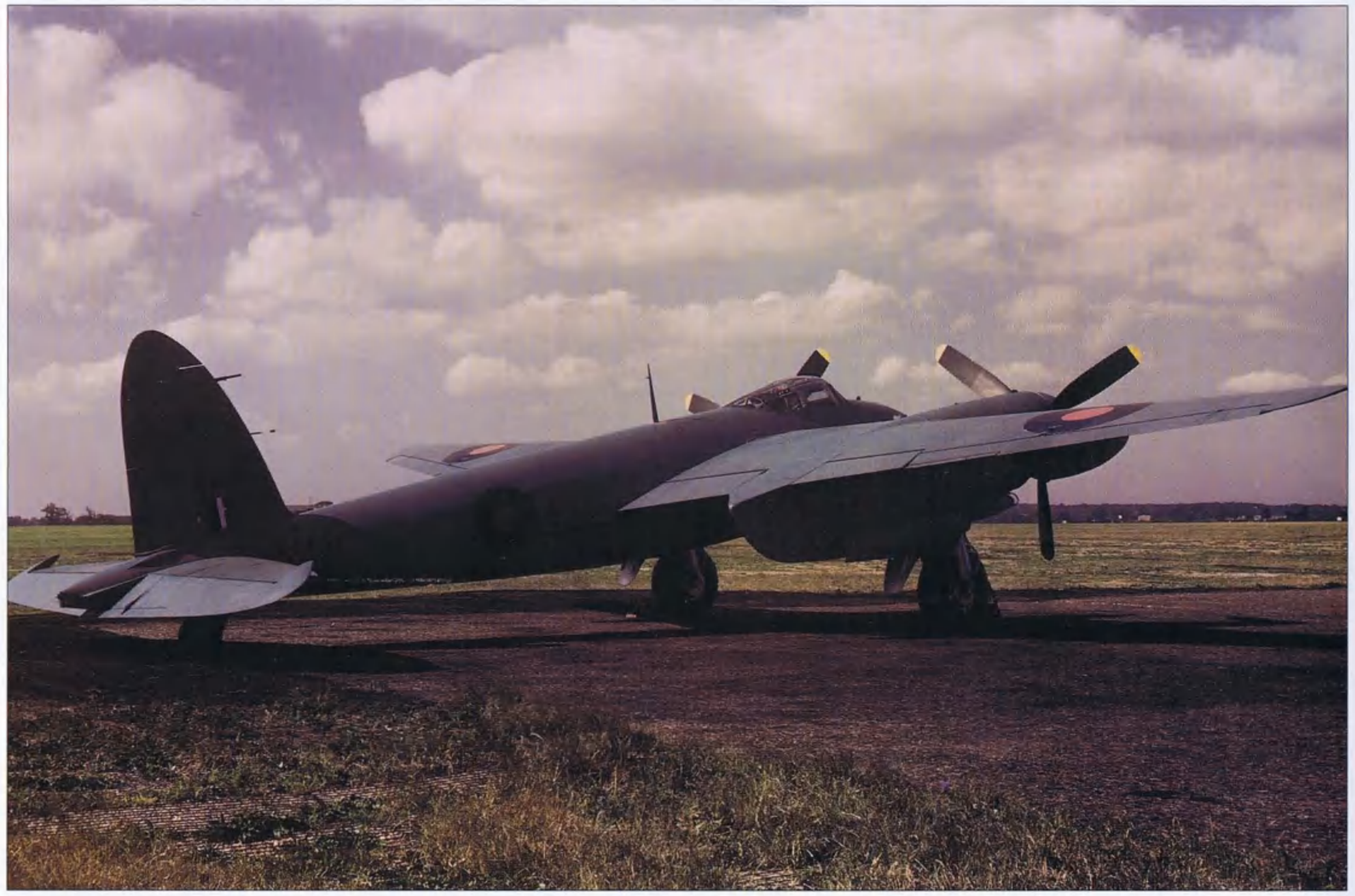
Model of the Supermarine Type 317 B.12/36 heavy bomber. Peter Green

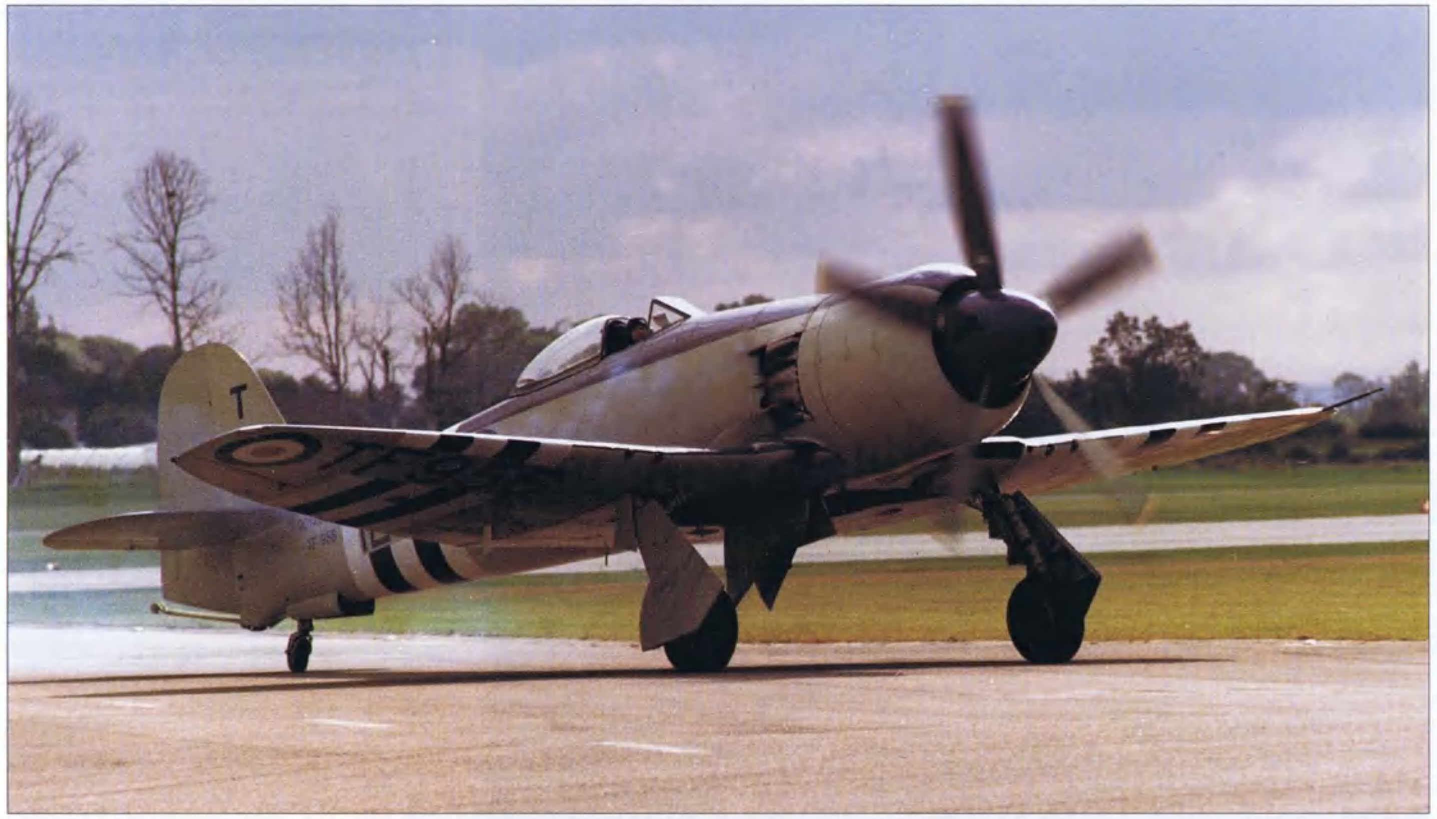


Model of the Hawker P.1005 medium bomber. Joe Cherrie

Poor quality but very rare colour view of Westland Whirlwind P7007 of No 263 Squadron, possibly taken in 1943. Fred Ballam, Westland







Opposite page:

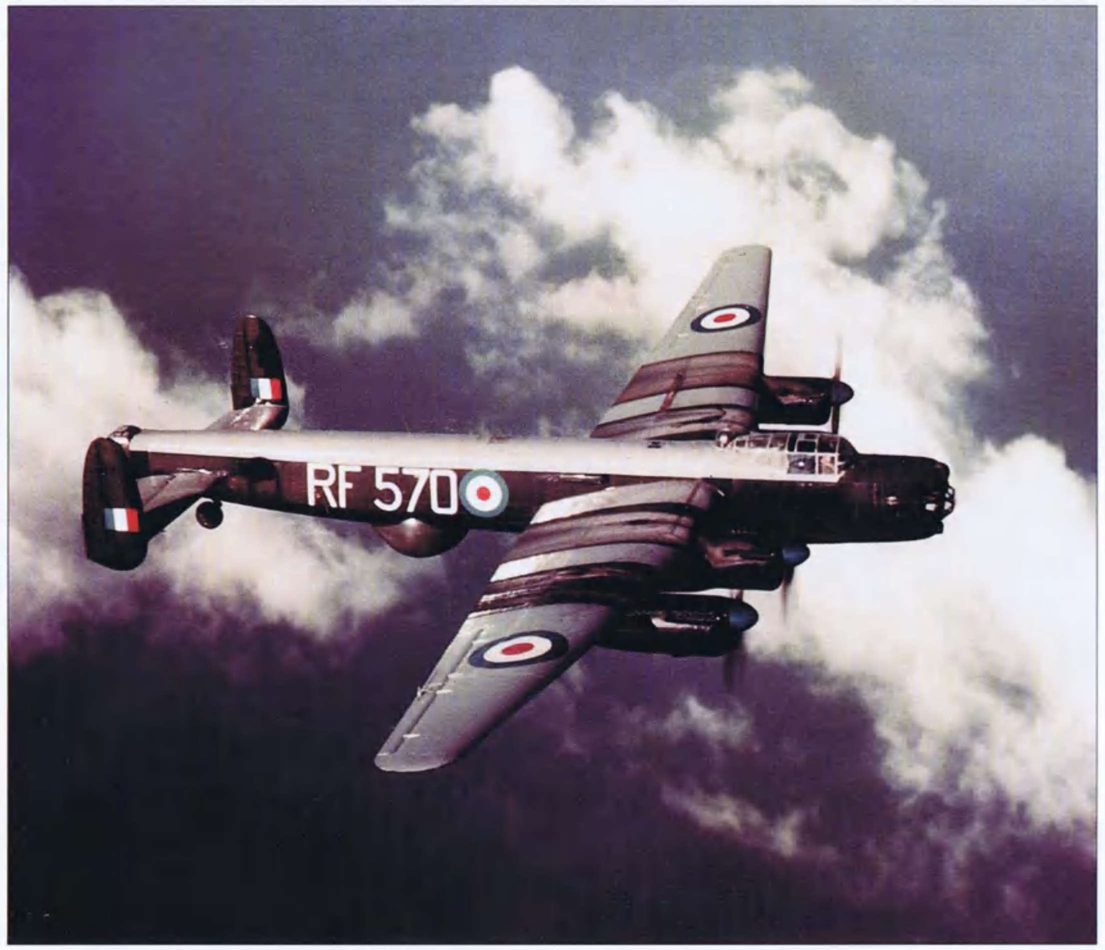
Line up of preserved RAF Second World War fighters. Gloster Gladiator K8042 is nearest, Hawker Hurricane P2617 next, then Supermarine Spitfire K9942 and finally black Boulton Paul Defiant N1671.

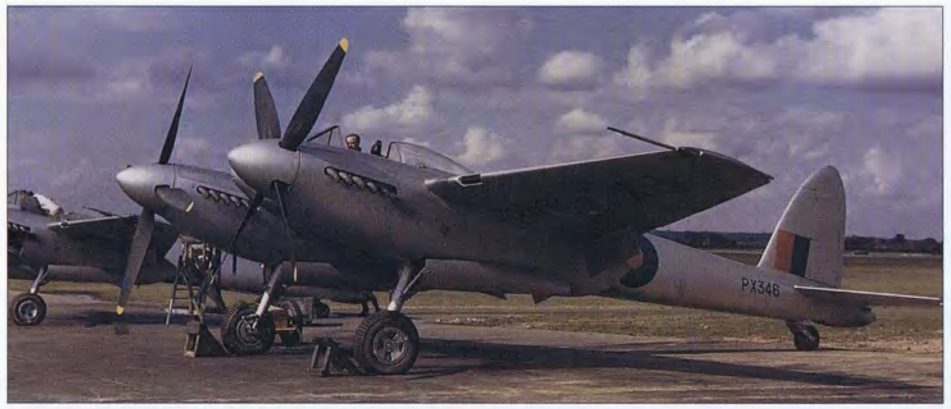
De Havilland Mosquito PR Mk.XVI NS591 was photographed at Hatfield in 1946. Barry Guess, BAE Systems, Farnborough

This page:

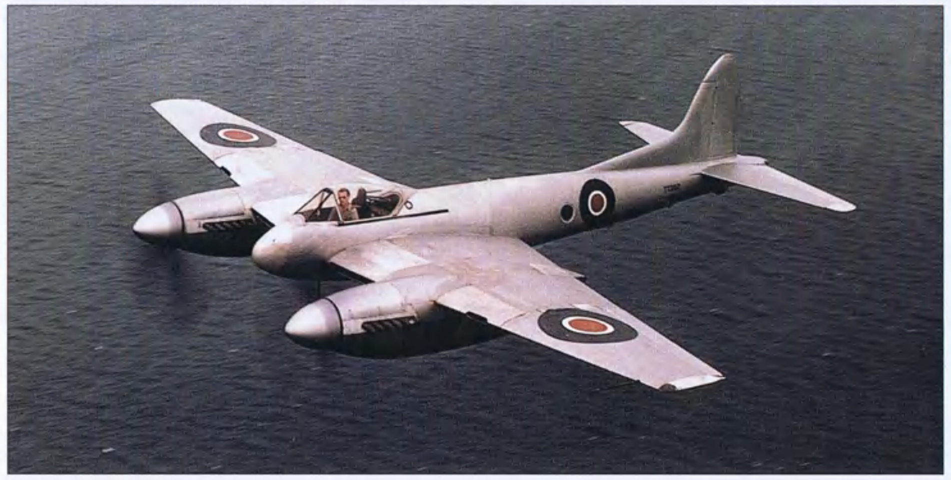
Preserved Hawker Sea Fury TF956 pictured in 1979. Eric Morgan

One of a well-known series of views of Avro Lincoln B Mk.II RF570 taken in about 1960 during its period of service with the Bomber Command Bombing School based at Lindholme. George Jenks, Avro Heritage



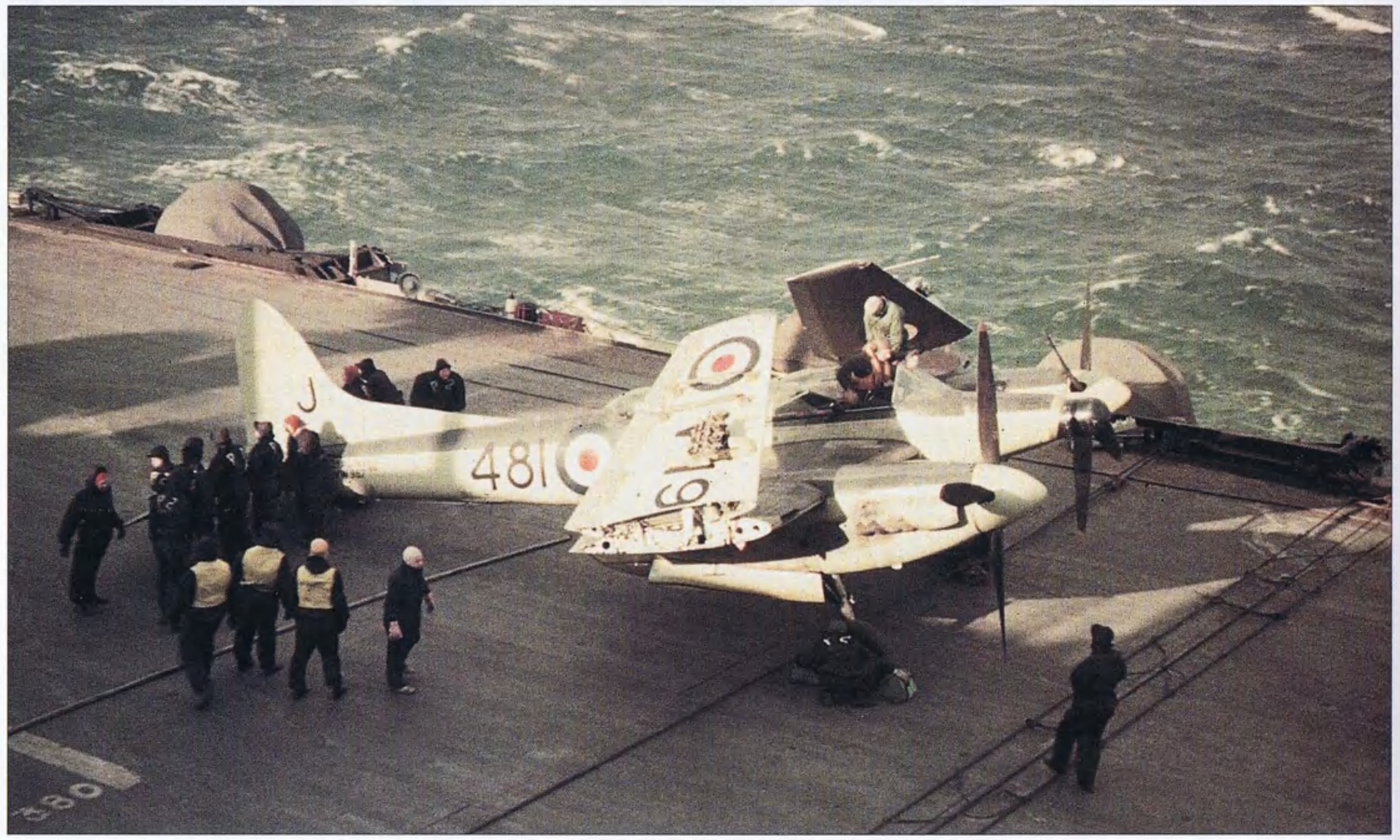


De Havilland Hornet F Mk.3 PX246, with small fin and rudder, is parked next to what appears to be the first production Sea Hornet TT186. This picture was almost certainly taken at Hatfield in August 1946. Barry Guess, BAE Systems, Farnborough.

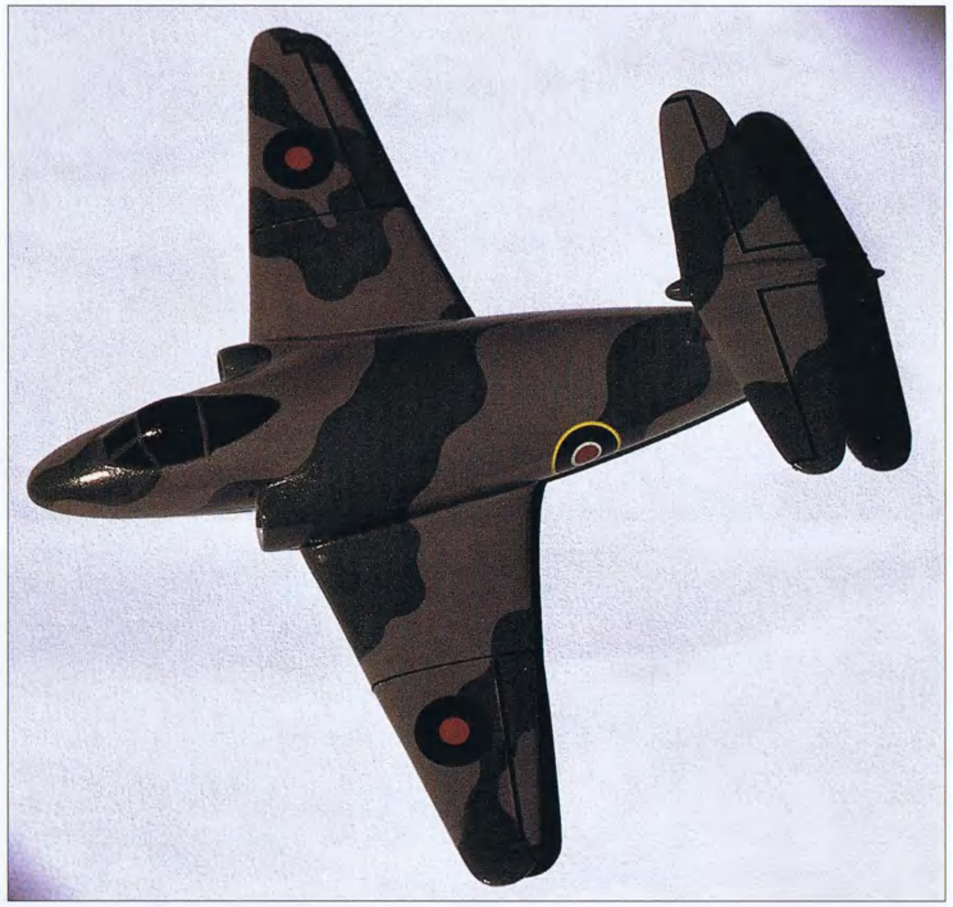


This gorgeous picture shows Sea Hornet F Mk.23 TT202 flying over the Solent in about June or July 1947. Barry Guess, BAE Systems, Farnborough.

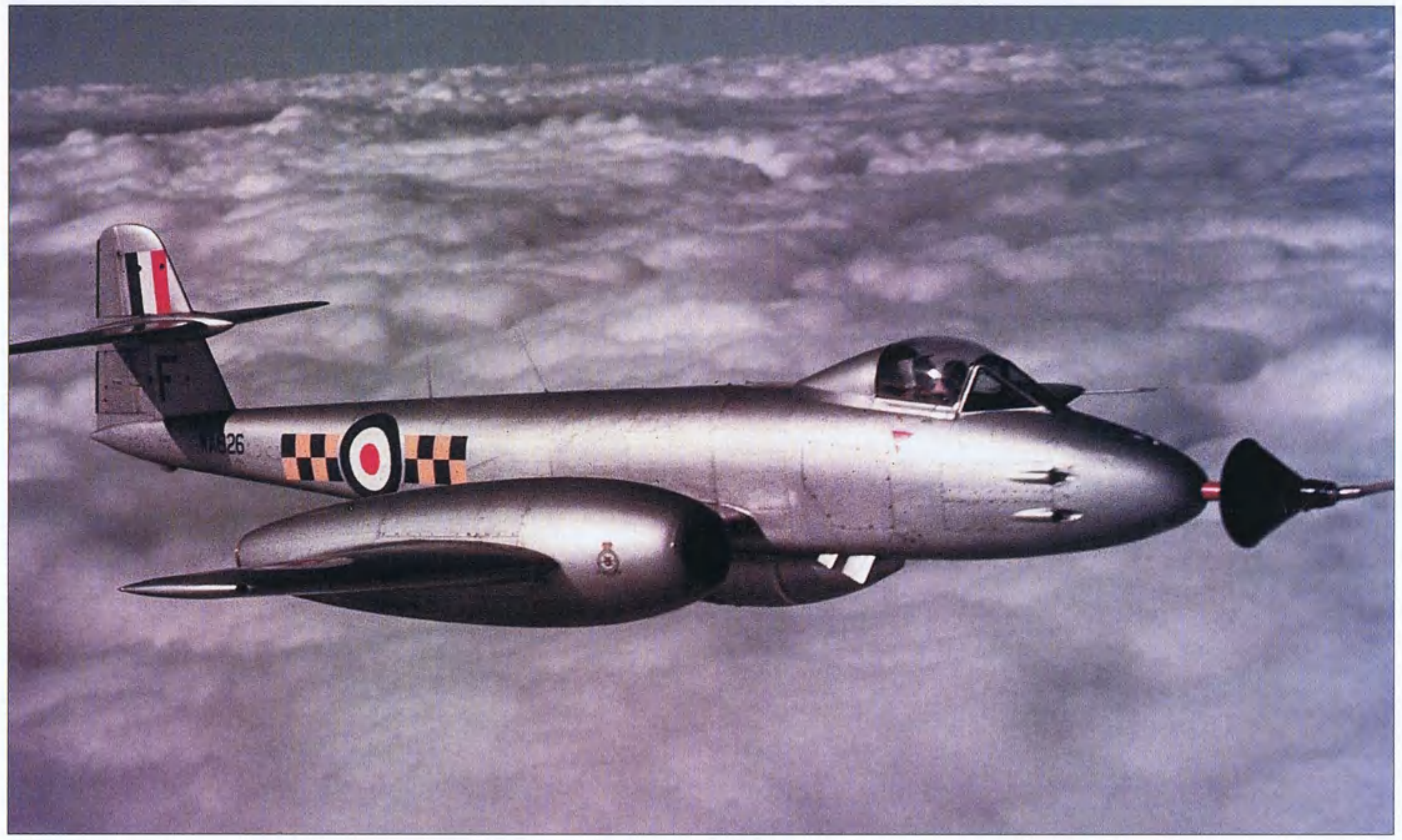
De Havilland Sea Hornet NF Mk.21 VW957 of No 809 Squadron being readied for flight aboard the carrier HMS *Eagle* in April 1954. Jet Age Museum



Model of the Gloster Rocket. Joe Cherrie

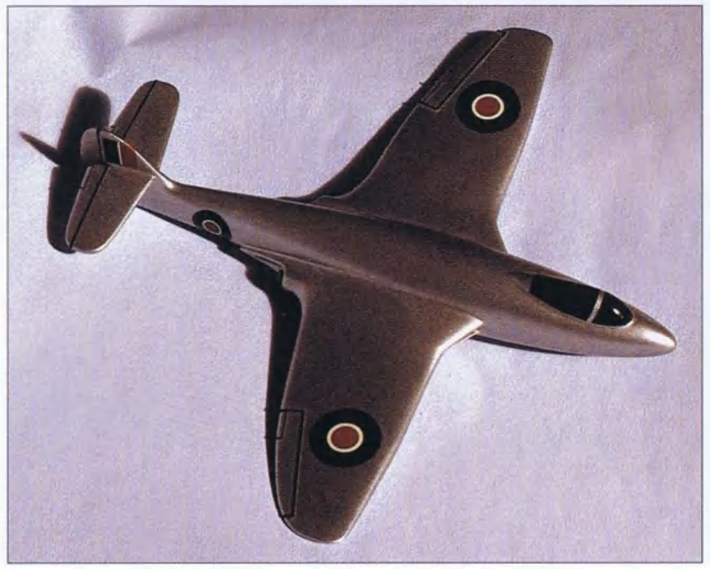


Gloster Meteor F Mk.8 WA826 of No 245 Squadron seen in July 1951 during in-flight refuelling trials. Jet Age Museum



De Havilland Vampire F Mk.1 TG370 pictured in the late 1940s. Barry Guess, BAE Systems, Farnborough

WE255 was the first production de Havilland Venom FB Mk.1 and is seen during the early 1950s whilst performing some underwing bomb carrying trials. Barry Guess, BAE Systems, Farnborough



Model of the Hawker 'Jet Tempest'. Joe Cherrie

Lovely view of Hawker Sea Hawk F Mk.1 WF159, probably taken between January and September 1953. Eric Morgan

Glossary

A&AEE	Aircraft and Armament Experimental Establishment, Martlesham Heath (pre-9.9.39), Boscombe Down (post-9.9.39).
ACAS(OR)	Assistant Chief of the Air Staff (Operational Requirements) [Air Ministry post].
ACAS(TR)	Assistant Chief of the Air Staff (Technical Requirements) [Air Ministry post].
ACM	Air Chief Marshal.
AMDP	Air Member for Development and Production.
AMRD	Air Member for Research and Development.
anhedral	Downward slope of wing from root to tip.
AoA	Angle of attack, the angle at which the wing is inclined relative to the airflow.
AI	Air interception (radar).
AP	Armour piercing.
AS	Armstrong Siddeley.
A/S	Anti-submarine.
aspect ratio	Ratio of wingspan to mean chord, calculated by dividing the square of the span by the wing area.
ASV	Anti-surface vessel (radar).
AVM	Air Vice Marshal.
AWA	Armstrong Whitworth Aircraft Ltd.
BP	Boulton Paul Aircraft.
CAS	Chief of the Air Staff [Air Ministry post].
CinC	Commander-in-Chief.
chord	Distance between centres of curvature of wing leading and trailing edges when measured parallel to the longitudinal axis.
CNR	Chief Naval Representative (to MAP).
CofG	Centre of gravity.
CRD	Controller of Research and Development [MAP post].
DAMDP	Deputy Air Member for Development and Production.
DC	Depth charge.
DCAS	Deputy Chief of the Air Staff [Air Ministry post].
DDOR	Deputy Director of Operational Requirements.
DD/RDT	Deputy Director/Research and Development (Technical).
DDTD	Deputy Director of Technical Development [MAP post].
DGRD	Director General of Research and Development.
DH	de Havilland.
dihedral	Upward slope of wing from root to tip.
DOR(A)	Director of Operational Requirements (Air).
DSR	Director of Scientific Research
DTD	Director of Technical Development [MAP post].
FAA	Fleet Air Arm.
HAL	Hawker Aircraft Limited.
HC	High capacity bomb.
HE	High explosive.
HMG	His/Her Majesty's Government.
HP	Handley Page.
HSG	Hawker Siddeley Group.
IAS	Indicated airspeed.
incidence	Angle at which the wing (or tail) is set relative to the fuselage.
ITP	Instruction to Proceed.
Laminar Flow Wing	Specifically designed to ensure a smooth flow of air over its surfaces with uniform separation between the layers of air.
MAEE	Marine Aircraft Experimental Establishment.
MAP	Ministry of Aircraft Production – created in May 1940 to relieve the Air Ministry of its role of procuring aircraft and the equipment and supplies associated with them. Functions transferred to the Ministry of Supply in 1946.
MC	Medium capacity bomb.
MoS	Ministry of Supply – created August 1939 to provide stores used by the RAF (and Army and Navy).
nm	Nautical mile.
NATO	North Atlantic Treaty Organization
OR	Operational Requirement.
OTU	Operational Training Unit
PR	Photo reconnaissance.
R & D	Research and Development.
RAAF	Royal Australian Air Force.
RAE	Royal Aircraft Establishment, Farnborough.
RDT	Research and Development (Technical).
RN	Royal Navy.
RNVR	Royal Naval Volunteer Reserve.
RP	Unguided rocket projectile.
RR	Rolls-Royce.
RTO	Resident Technical Officer.
TAS	True airspeed.
t/c	Thickness/chord ratio.
TRE	Telecommunications Research Establishment, Malvern.
TT	Torpedo.
USAAF	United States Army Air Force.
USN	United States Navy.
VCAS	Vice Chief of the Air Staff.

Appendix One

British Military Aircraft Project Summary

During their years of independence many of Britain's aircraft firms became wedded to certain types of aeroplane or areas of manufacture. Hawker, for example, was always a fighter specialist while Avro, Handley Page and Vickers usually built or designed many heavy bombers. Blackburn and Fairey were regular suppliers of aircraft to the Fleet Air Arm and this often influenced their lines of development.

The following lists all known fighter and bomber designs and projects produced by the companies between 1935 and the mid to late 1940s (until they roughly overlap with the project lists in *British Secret Projects Volumes 1* and *2*). Selected earlier types that were still in production are also included together with research types that were developed essentially to advance the designer's art. To hold the list to manageable proportions, pure trainer, reconnaissance, air/sea rescue developments and the like, are omitted. In theory, all projects are 'official', despite some schemes having such a brief life that they really have no right to be here but sneak in as one cannot always determine which they are; in fact some of the designs that are here can really only be considered as draft or provisional layouts. Information for a good number of World War Two projects does not appear to have survived and has probably been lost forever. In addition, with so many firms and specifications (to which many projects were prepared without project numbers) it is impossible to say how complete this list is. Finally, some wartime jet fighter and bomber projects are listed here only briefly because they were covered in more depth by the previous volumes in this series, where they essentially formed part of the post-war story.

AIRSPEED (taken over by de Havilland in 1940)

AS.29 Bomber to B.1/35 with four Bristol Aquila or RR Goshawks, 2.36.

AS.31 High-speed project to 35/35, 1936. Twin booms, cabin nacelle on tail, one Merlin E engine and eight Browning machine guns in wings outboard of booms. Project not proceeded with.

AS.47 High-speed all wood twin-boom bomber project with two 2,200hp (1,641kW) Napier Sabres, 1939/40. One tractor unit, one pusher with pilot and navigator/bomb-aimer in between in slightly offset cockpit. Span 58ft (17.7m), length 53ft 9in (16.4m), top speed 470mph (756km/h) at 18,500ft (5,639m), range 1,000 miles (1,609km) with 1,000lb (454kg) bombs.

AS.48 Projected single-seat night fighter with 2,150hp (1,603kW) Napier Sabre and six 20mm cannon (possibly six in each wing), 1939/40. Span 40ft (12.2m), length 40ft (12.2m), top speed 425mph (684km/h) at 21,500ft (6,553m), time to 20,000ft (6,096m) 6 minutes, service ceiling 36,000ft (10,973m). Provisional drawings prepared 1939, mock-up built at Hatfield but drawings, data and mock-up destroyed in bombing raid on Hatfield 3.10.40. Project cancelled.

AS.52 Bomb-carrying glider based on Horsa to X.3/41, 1941.

AS.56 Projected single-seat fighter to F.6/42, 8.9.42.

ARMSTRONG WHITWORTH

Two-seat fighter Unnumbered development of AW.34 fighter project of 1934 prepared to F.9/35, 8.35. Prototype serial allocated but never built.

AW.38 Heavy bomber developed to B.3/34 and first flown 17.3.36. Entered service as Whitley.

AW.39 Whitley bomber development to B.1/35, 7.35.

AW.41 Albemarle bomber, first flown 5.40.

AW.42 Four-engine bomber to B.12/36, 9.36.

Turret fighter Unnumbered twin-engine turret fighter to F.11/37, 8.37.

AW.44 Development of Albemarle with four Merlins, 10.39. Span 84ft 6in (25.8m), length 59ft 11in (18.3m).

AW.45 Twin Merlin-engined aircraft, probably bomber or recce, with three crew and front crew compartment pressurised for high-altitude operations, 1939/40. Appeared to have no defensive armament. AWA's new long-travel tricycle undercarriage fitted and construction in light alloy monocoque. Span 43ft (13.1m), length 36ft 3in (11.0m).

AW.46 Four-engine scaled-up version of AW.45 near identical in shape and layout to earlier form, c1940. Three crew, no defensive armament, ten bombs in wings, two in fuselage. Span 70ft 2in (21.4m), length 47ft 1in (14.4m).

AW.47 Bomber project believed prepared to B.3/40, 9.40.

AW.48 Heavy bomber to B.1/39, 17.4.39.

Light High-Speed Day Bomber Unnumbered project to B.7/40, 9.40.

Four-engined Whitley Unnumbered scheme prepared in 1941 to meet RAF need for high-performance heavy bomber. To ensure use of existing Whitley jigs and tools, as much original Whitley structure as possible retained and four Bristol Centaurus III or Wright Cyclone engines fitted, two replacing the Merlins, two more mounted on new wing sections placed between existing centre and outer wing sections. Tailplane and elevators enlarged, four standard Whitley fins and rudders fitted and structure strengthened; bomb load increased to 24,000lb (10,886kg). Span 135ft (41.1m), length 72ft 6in (22.1m), all-up-weight 90,000lb (40,824kg), top speed 295mph (475km/h). Little Ministry interest (Whitley by now considered obsolete).

AW.49 Ground attack aircraft, 9.42.

AW.50 Flying wing jet bomber; design study tendered to MAP mid-12.42 but soon abandoned.

AW.51 One-third scale wood glider to test aerodynamics of highly experimental AW.50, 1943.

AW.52 Experimental tailless aircraft to E.9/44 to test flying wing concept for large aircraft. AW.52G scale glider flew 2.3.45. First of two AW.52s flew 13.11.47.

AW.53 Twin-engined torpedo bomber to S.6/43, 4.43.

AW.54 Redesign of AW.53 to S.11/43, 6.43.

AW.54A Recce bomber with two MetroVick F.3 turbojets, 1943.

AVRO

672 Torpedo bomber/reconnaissance aircraft to M.15/35, 10.35. Based on Anson reconnaissance and training aircraft.

675 Torpedo bomber general reconnaissance aircraft to G.24/35, late 1935.

678 Unconventional fighter design powered by single Merlin driving twin two-blade airscrews, 8.36. Span 34ft 0in (10.4m), length 30ft 6in (9.3m).

679 Bomber project to P.13/36. Became Manchester, first flown 25.7.39. Several proposals with alternative engines plus, c1939, development with cannon turrets.

680 Heavy bomber to B.1/39, 4.39. No detail drawings completed.

681 Heavy bomber project, c1939.

682 Heavy bomber project, c1939.

Close-Support Bomber Unnumbered project possibly prepared for B.20/40, 11.40.

683 Heavy bomber development of Manchester with four Merlins. Became Lancaster, first flown 9.1.41.

684 Stratosphere bomber development of Lancaster, 16.8.41.

High-speed Lancaster Version with streamlined nose, 1942.

'75 Ton Bomber' Two designs, 18.1.43.

694 B Mk.IV and V Lancaster developments to B.14/43. Renamed Lincoln and first flown 9.6.44.

696 Anti-submarine aircraft to R.5/46. Became Shackleton, first flown 9.3.49.

BLACKBURN

B.20 Small flying boat to R.1/36 first flown late March/early April 1940.

B.21 Torpedo bomber reconnaissance monoplane to S.24/37, 1937.

B.22 Torpedo bomber reconnaissance aircraft to S.30/37, 5.37. Two Bristol Aquila A.E.3 or Napier Rapier VI engines.

B.23 Botha Mk.II private venture project, 1938. Abandoned for B.27.

B.24 Skua naval fighter/dive bomber to O.27/34 first flown 9.2.37.

B.25 Roc two-seat fleet turret fighter to O.30/35 first flown 23.12.38.

B.26 Unnumbered projects proposed to M.15/35 and G.24/35 (both late 1935). Combined into B.26 for 10/36 (1.36) and, as Botha Mk.I, first flown 28.12.38.

B.27 Botha Mk.II private venture project with two 1,400hp (1,044kW) Bristol Hercules engines, late 1930s.

B.28 Private venture high-speed light bomber and reconnaissance development based on Botha to B.3/40, 1939.

B.29 Torpedo bomber reconnaissance monoplane to S.24/37 with RR Exe, 1938. Was replacement for Blackburn Shark but cancelled in favour of B.36.

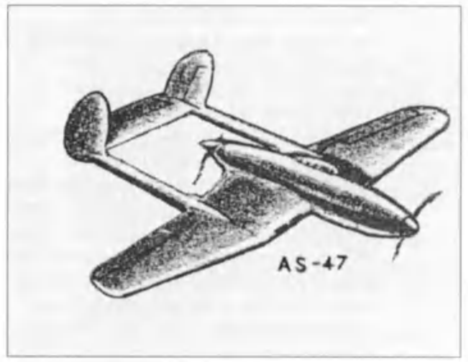
B.30 Heavy bomber to B.1/39, 4.39.

B.31 Naval fighter fitted with rear turret to N.9/39, c8.39.

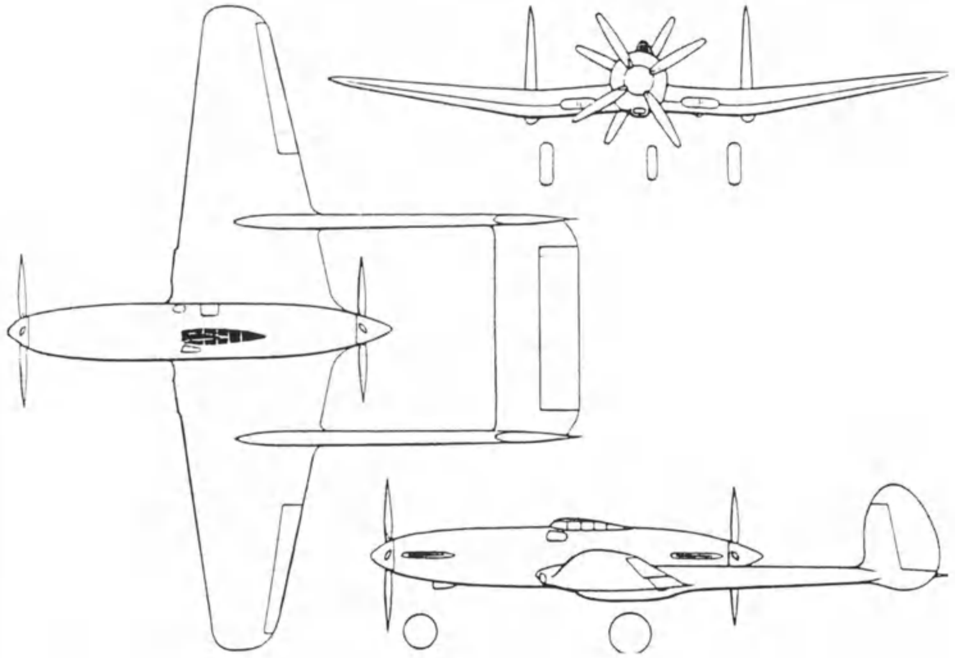
B.32 Four-engined flying boat to R.5/39, 19.6.39. Replaced by B.39.

B.33 Naval fighter to N.8/39, 1939.

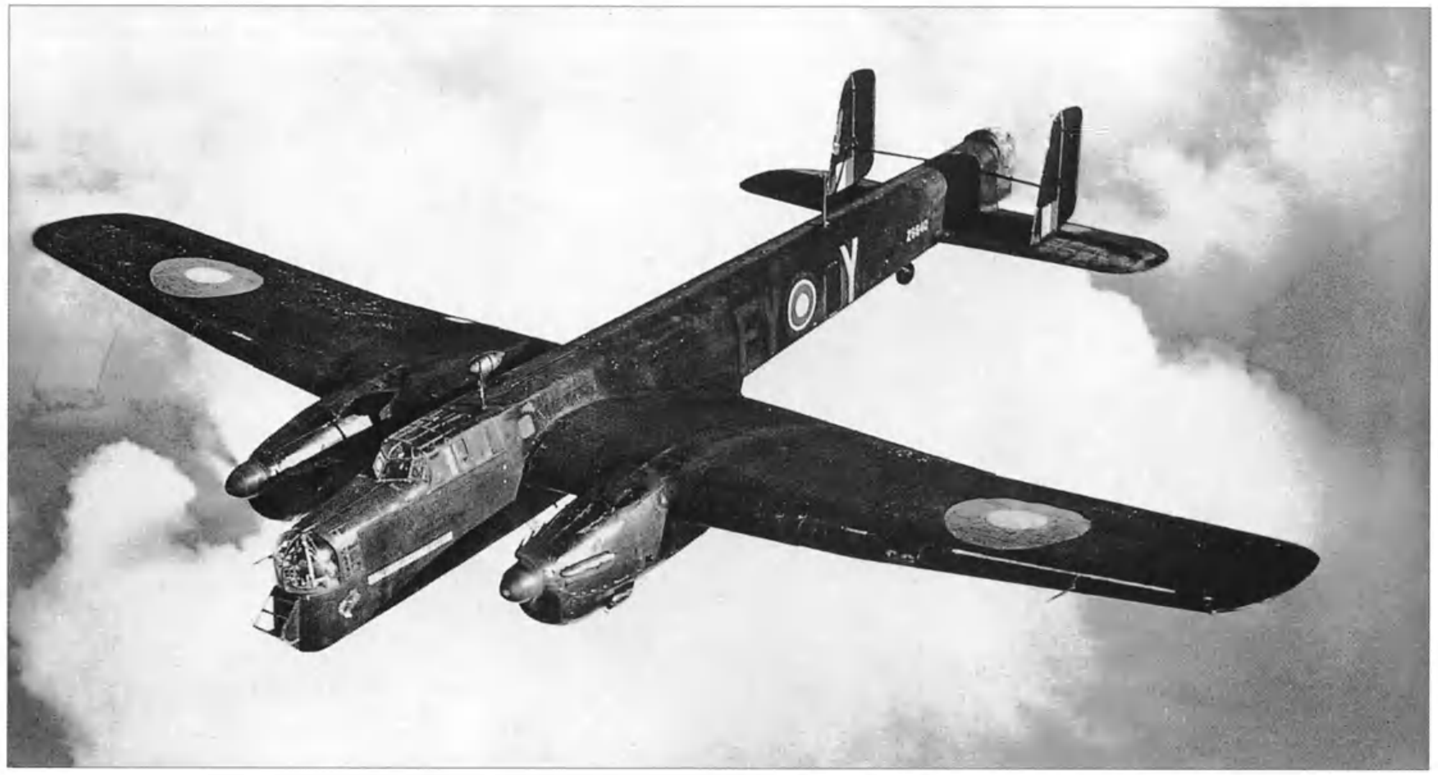
B.36 Torpedo reconnaissance aircraft to S.24/37, 16.6.38.



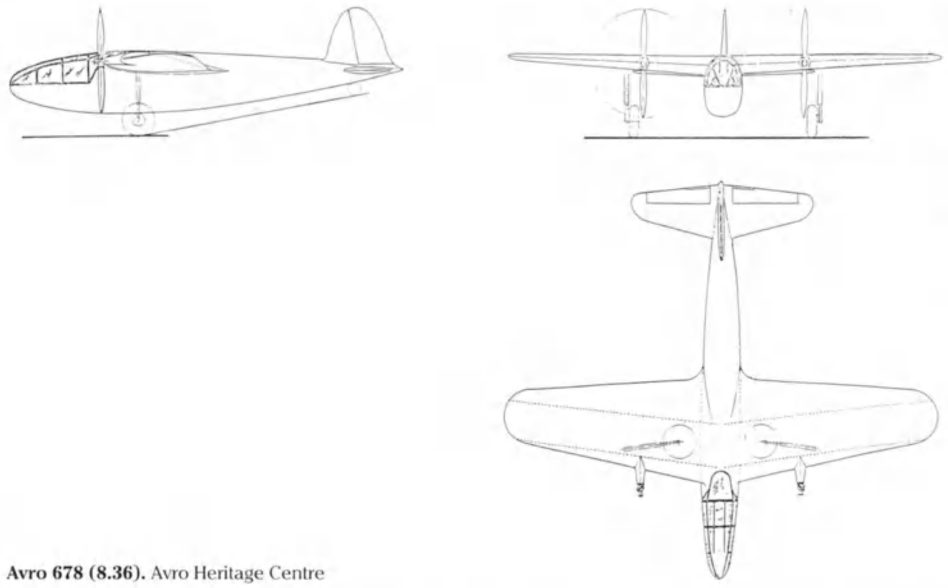
Artist's impression of the AS.47.



Airspeed AS.47 (1939/40). Bob Beard



Armstrong Whitworth Whitley. Z6640 'Y' was a B Mk.V powered by two Merlin X.



Avro 678 (8.36). Avro Heritage Centre

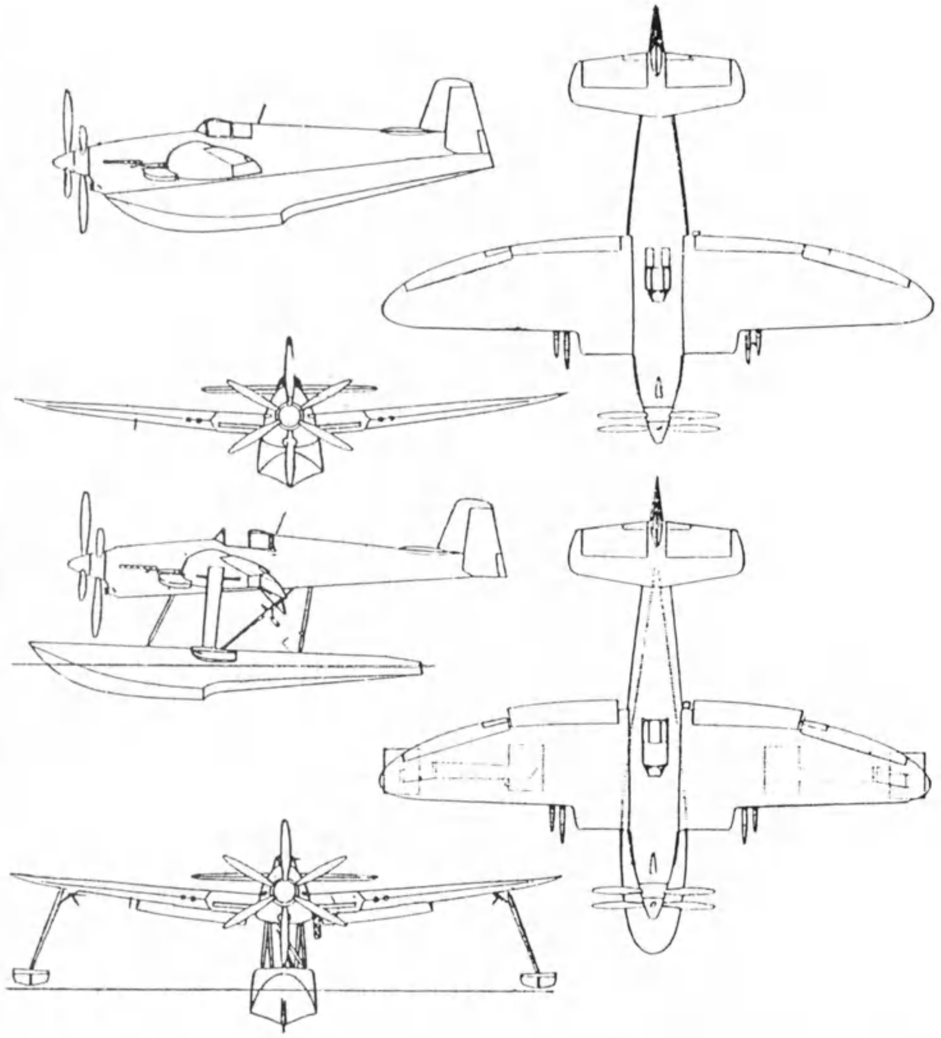
Blackburn Skua naval fighter and dive bomber serial L3007.

Blackburn Roc naval turret fighter serial L3084.

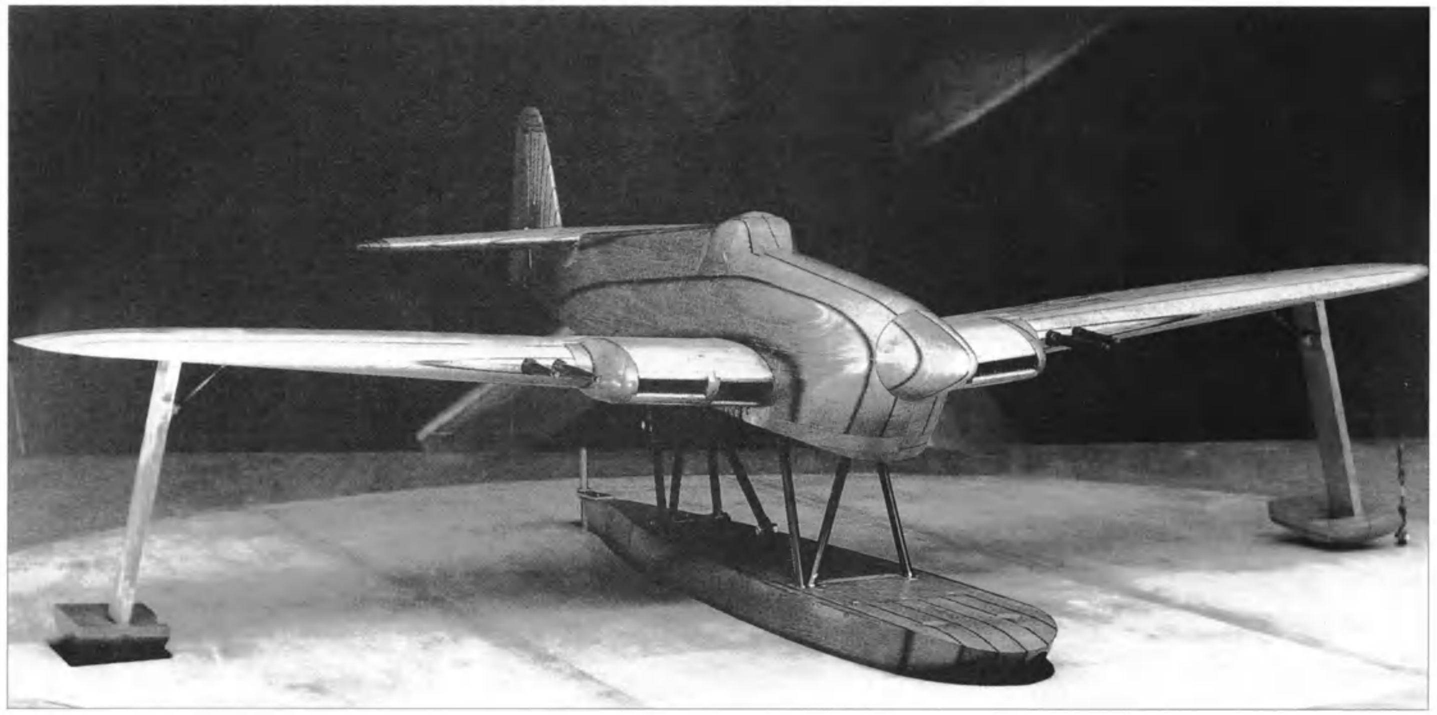
B.37	Single-seat fighter, 1940. Became Firebrand Mk.I, first flown 27.2.42.
B.39	Flying boat to R.5/39 with two Centaurus engines, 1940.
B.40	Proposed improvement of B.20 with Centaurus, 1940. Covered by R.13/40.
B.41	Single-seat RAF fighter based on the B.37 Firebrand I, 1940.
B.42	Firebrand design study with high-lift wing, 1942.
B.43	Single-seat twin-float fighter with Napier Sabre, 1942. Based on B.37 Firebrand.
B.44	Alternative float fighter to B.43 twin-float Firebrand designed to N.2/42, 1.43. Designed by Maj J D Rennie and embodied retractable planing bottom (pontoon) developed from B.43 and carried on retractable struts (also drew on B.20 experience). Ability to change from land to water undercarriage part of initial requirement when work began on Firebrand. B.44 primarily designed for operations from sheltered waters but intention also to hoist aircraft out from escort carriers when out of range of shore bases. After take-off, planing bottom retracted to lie flush with fuselage and stabilising floats would retract inwards into mainplane. Concept intended to remove extra weight and drag of fixed floats. B.44 could be adapted to carry two 500lb (227kg) bombs or two 90gal (409lit) drop tanks; in other respects was standard single-seat fighter powered by single Sabre Mk.IV. Span 50ft (15.2m), length 39ft 4in (12.0m), wing area 381ft^2 (35.4m^2), maximum 360mph (579km/h) at 25,000ft (7,620m), ceiling 38,000ft (11,582m), range 1,000 miles (1,609km). Armed with four 20mm Hispano cannon in wings outside leading edge intakes. RAE tested suitability of initial pontoon proposal to operate from sea but found would probably suffer from porpoising during take-off while spray would damage propeller. Calculations indicated take-off doubtful even with normal load. Modified pontoon judged satisfactory regarding stability, spray formation and water drag, but turning required to clear spray at low speeds. Mock-up built but did not proceed beyond design stage. Success in building ground airfields quickly after amphibious landings ended need for type like B.44.
B.45	Firebrand TF Mk.III fitted with Bristol Centaurus VII to S.8/43. Flown 21.12.43.
B.46	Firebrand variants TF Mks.4, 5 and 5A.
B.47	Dive and torpedo bomber project to O.5/43, 19.4.43.
Reconnaissance Bomber	Project to S.11/43, 25.6.43.
B.48	'Firecrest' development of Firebrand to S.28/43. First flown 1.4.47 as Y.A.1. Version planned with Sabre to S.10/45.
B.50	Jet-powered FAA strike aircraft with one RR Nene submitted to Air Ministry 17.2.45. Two variants with single and twin booms.
B.62	Propeller-turbine conversion of B.48 with Proteus, Clyde or Mamba powerplant, 15.4.46. Designated Y.A.6.
B.78	Maritime flying boat to R.2/48(?), 1949.

BOULTON PAUL

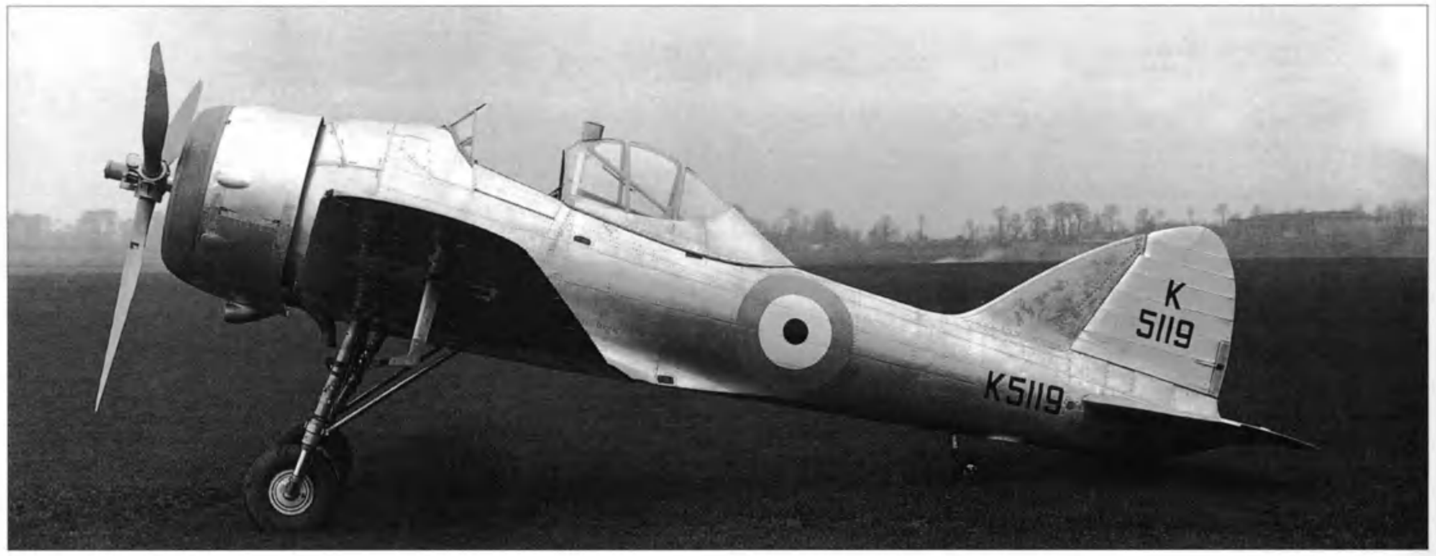
P.79	Heavy bomber originally proposed to B.3/34; updated to B.1/35 in 6.35.
P.82	Two-seat day and night fighter to F.9/35, mid-1935. Became Defiant first flown 11.8.37.
P.83	Shore-based torpedo bomber to M.15/35, 12.35.
P.84	General reconnaissance aircraft to G.24/35, 12.11.35.
P.85	Two-seat fleet fighter to O.30/35, late 1935. Navalised Defiant with one Hercules HE.1.SM but lost competition to Blackburn Roc. Production Rocs built by Boulton Paul as P.93.
P.86	Combined general reconnaissance and shore-based torpedo bomber to 10/36, 2.36.
P.87	Heavy bomber with two modified Merlins, 1936.
P.88	Single-seat fighter to F.37/35 with alternative Hercules HE.1.SM or RR Vulture, 5.36. L6591 and L6592 allocated to prototypes but never built.
P.89	Two-seat four 20mm cannon fighter with two modified RR Kestrel XVI engines designed to F.9/37, 1937. No drawings or data known to have survived.
P.90	Heavy bomber to B.12/36 with four Kestrel KV.26, 1.10.36.
P.91	Medium bomber to P.13/36 with two Vultures, 6.1.37.
P.92	Twin-engine two-seat turret fighter to F.11/37, 30.7.37. Prototype ordered but never completed. Scale model P.92/2 built by Heston Aircraft as J.A.8 and flown spring 1941.



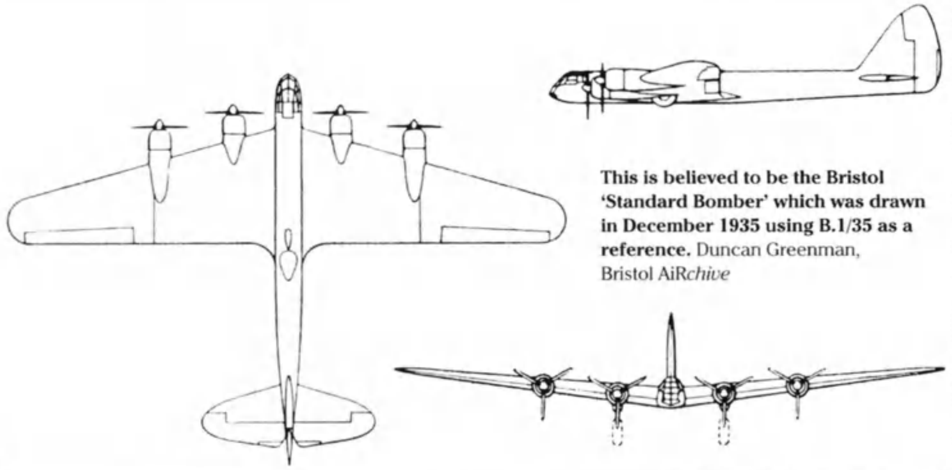
Blackburn B.44 showing the retractable float (1.43). BAE Systems Brough Heritage Centre



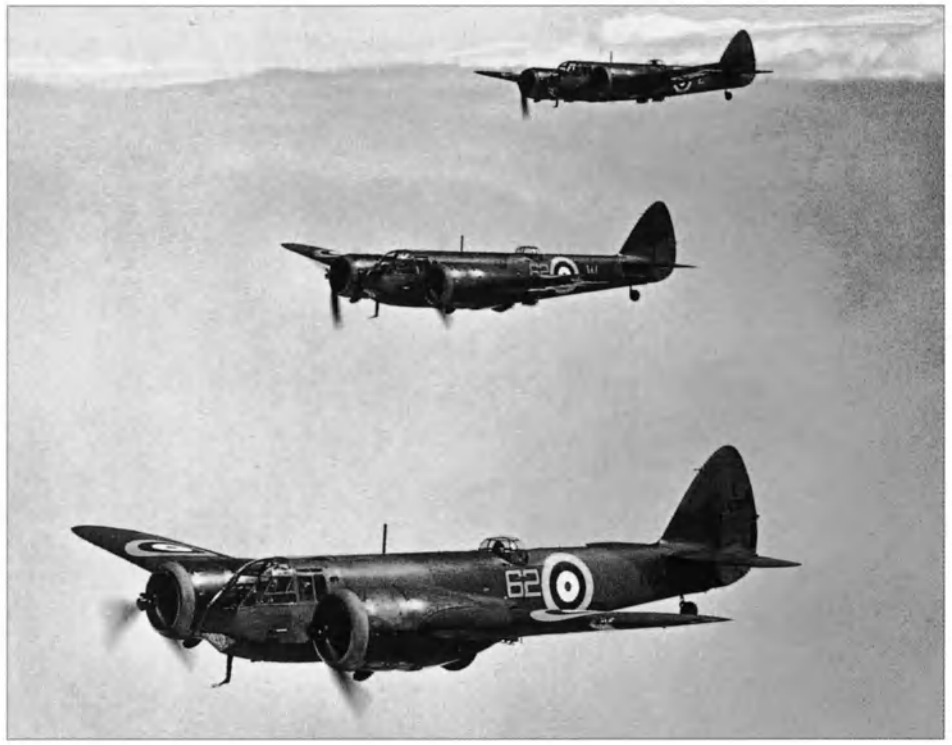
Wind tunnel model of Blackburn B.44 flying boat fighter, photo dated 4.1.43. BAE Systems Brough Heritage Centre



The Bristol Type 146 prototype K5119 was built to F.5/34. Jim Oughton

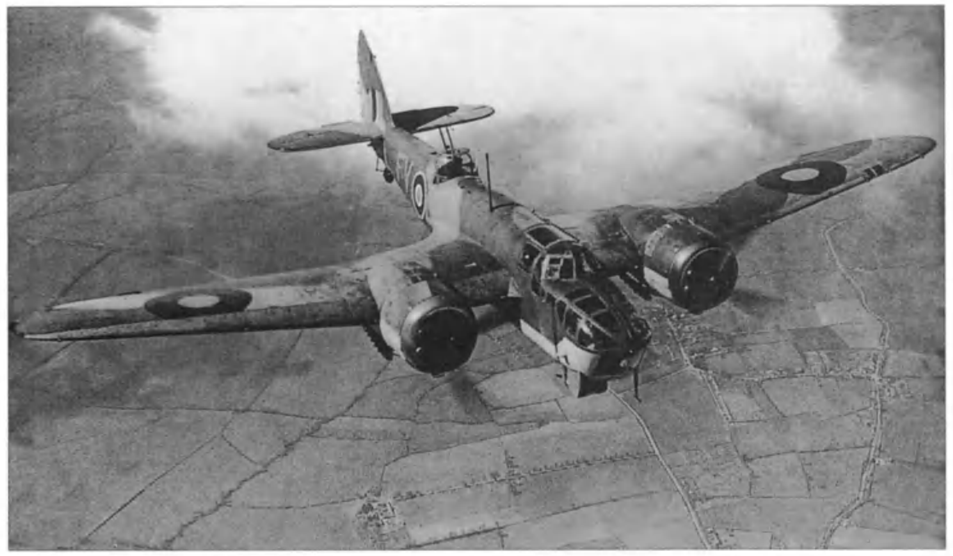


This is believed to be the Bristol 'Standard Bomber' which was drawn in December 1935 using B.1/35 as a reference. Duncan Greenman, Bristol AiR*chive*



Bristol Blenheim Mk.Is; L1131 nearest.

P.93 Designation covering Blackburn Roc detail design, prototypes and production.
P.94 Single-seat Defiant development with 1,280hp (954kW) Merlin XX, mid-1940.
P.95 Single-engine two-seat bomber to B.20/40 with Bristol Hercules VI, c11.40.
P.96 Single Napier Sabre-engined two-seat two-cannon turret fighter to F.18/40, c11.40. Five versions proposed.
P.97 Twin Sabre two-seat night fighter to F.18/40, c11.40. Two versions P.97A and B.
P.98 Single-seat tail-first pusher fighter with single engine and contra-rotating propellers to F.6/42, 5.9.42. Three versions P.98A, B and C with alternative engines.
P.99 Low-level single-seat pusher ground attack fighter with twin booms, 6.10.42. One RR Griffon and contra-rotating propellers.
P.100 Low-level single-seat tail-first pusher ground fighter, 6.10.42. One Griffon and contra-rotating propellers.
P.101 Low-level biplane ground attack fighter with one Centaurus CE.12.SM, 6.10.42.
P.102 Single-seat naval fighter driven by Whittle W2B jet, early 1943. No details survive but not linked to Jet Barracuda.
Jet Barracuda Project to add one Power Jets W2B/37 engine in Fairey Barracuda torpedo bomber (Boulton Paul then undertaking production), c1942. Aimed at boosting aircraft's attacking performance in anti-shipping mode by putting jet in tail to 'augment' piston unit. No project number issued.
P.103 Single-seat naval fighter with Griffon or Centaurus to N.7/43, 4.43. Two versions P.103A and B.
P.104 Single-seat naval tail-first pusher fighter with one Griffon to N.7/43, 4.43.
P.105 Single-engine naval aircraft with one Centaurus, 1.44.
P.107 Two-seat land-based escort fighter with one Centaurus, 4.44.



Later marks of Blenheim had a longer nose. V6083 was a Mk.IV.

Bristol Type 160 Blenheim Mk.V (originally called Bisley Mk.1) AZ930. Peter Green

BRISTOL

Heavy Bomber Project to B.1/35, 3.7.35.
142M Medium bomber development of Type 142 airliner to 28/35. Became Blenheim first flown 25.6.36. Developments tendered to M.15/35 (3.12.35) and G.24/35 (18.11.35). Version also served as a night fighter.
143 Initial military development of Type 142 and flown 20.1.36 as test bed for Bristol Aquila engine.
144 Heavy bomber tendered to B.3/34, mid-1934.
146 Single-seat fighter to F.5/34 first flown 11.2.38.
147 Two-seat turret fighter to F.9/35 with Perseus engine, 17.8.35. Type 147A (9.35) had more powerful Hercules.
'Standard Bomber' Four-engine development of Blenheim, 12.35. Potential of Blenheim examined in terms of land-based bomber and torpedo bombers and this variant proposed using B.1/35 specification and extrapolating Type 142 performance data. Attached drawing, believed to be this project, had same front fuselage as Blenheim I, four Mercury IX or Taurus engines, four crew. Span 96ft (29.3m), length 68ft (20.7m), top speed 275mph (442km/h) (Mercury IX) or 300mph (483km/h) (Taurus), all-up-weight 37,500lb (17,010kg) (Mercury) or 38,500lb (17,464kg) (Taurus), range 225 miles (362km). As result, company invited to tender to B.12/36 and P.13/36.
Single-Seat Fighter Project with alternative engines to F.18/37, 2.5.38.
149 Bolingbroke Mk.1 and Blenheim Mks.II and IV.
150 Torpedo bomber to M.15/35, 3.12.35.
151 High-speed experimental aircraft to 35/35, early 1936.
152 Beaufort to 10/36, first flown 15.10.38.
153 Cannon-armed fighter, single engine, to F.37/35, 30.4.36.
153A Cannon-armed fighter, twin engine, to F.37/35, 5.36.
Medium Bomber Unnumbered project to P.13/36, 6.1.37.
Heavy Bomber Unnumbered project to B.12/36, 15.4.37.
Turret Fighter 'Small' and 'Large' versions of design to F.11/37, 8.37.
Torpedo Bomber Unnumbered project to S.24/37, 8.3.38.
Fighter Unnumbered projects to F.18/37, 2.5.38.
155 Twin-engined wood and steel composite bomber to B.17/38, 1938. Later replaced by AWA AW.41 Albemarle.
156 Beaufighter two-seat fighter first flown 17.7.39.
157 Three-seat bomber Beaufighter with dorsal turret believed prepared to B.19/38, 1.39.
158 Slim fuselage Beaufighter Mk.III, 1.39. Prototype never completed.
159 Heavy bomber to B.1/39, 4.39.
160 Bisley Mk.1 to B.6/40 first flown 24.2.41. Later entered service as Blenheim Mk.V.
161 Medium bomber, mid-1940.
162 Medium bomber ('Beaumont'), 2.10.40.
163 Revision of Type 162 Beaumont to B.2/41 which became Buckingham medium bomber first flown 4.2.43. Jet-powered Buckingham suggested 9.41.
164 'Buccaneer' torpedo bomber prepared to H.7/42, 8.42 onwards. Further developed as Type 164 Brigand, first flown 4.12.44.
'75 Ton Bomber' First proposals 15.11.42; two designs submitted 1.43.

CUNLIFFE-OWEN

Ground Attack Aircraft Design studies in response to Air Staff enquiries, 8 & 10.42.
Torpedo Bomber Reconnaissance Aircraft Study to S.6/43, 4.43.
Dive/Torpedo Bomber Project to O.5/43, 4.43.

DE HAVILLAND

DH.98 Unarmed bomber proposal of 9.39 onwards which became Mosquito. First flown 25.11.40 and built in many versions. 'Jet Mosquito' proposal also drawn.
DH.99 High-speed bomber development of Mosquito to B.11/41, first considered early 1941. Soon renumbered DH.101. DH.99 reallocated to jet fighter and then to civil design.
DH.100 Vampire jet fighter first flown 20.9.43 (project begun as DH.99).
DH.101 High-speed bomber to B.11/41. Abandoned 4.42.
High-Speed Unarmed Night Bomber Believed to be Mosquito development with four Merlins put forward as 'fast' heavy bomber, 1941.
DH.102 'Mosquito II' high-performance bomber to B.4/42, 5.42. Cancelled 12.42.
DH.103 Hornet and Sea Hornet high-speed twin-engine fighter first flown 28.7.44.
DH.107 Proposed Vampire development which eventually became Venom, c1946.
DH.112 Venom thin wing development of Vampire first flown 2.9.49. Sea Venom developed for FAA.

FAIREY

Fairey did not make full use of project numbers and, consequently, this list only contains projects known to have existed. There almost certainly will have been more, particularly for the late 1930s, but details are lacking.
Battle Light bomber first designed to P.27/32 and first flown 10.3.36.
Swordfish Torpedo spotter reconnaissance aircraft produced under Specification 38/34. Prototype first flew 17.4.34.
P.4/34 Light bomber prototype based on Battle and first flown 13.1.37. Used as a flying mock-up for Fulmar fighter.
Heavy Bomber Project to B.1/35, 6.35.

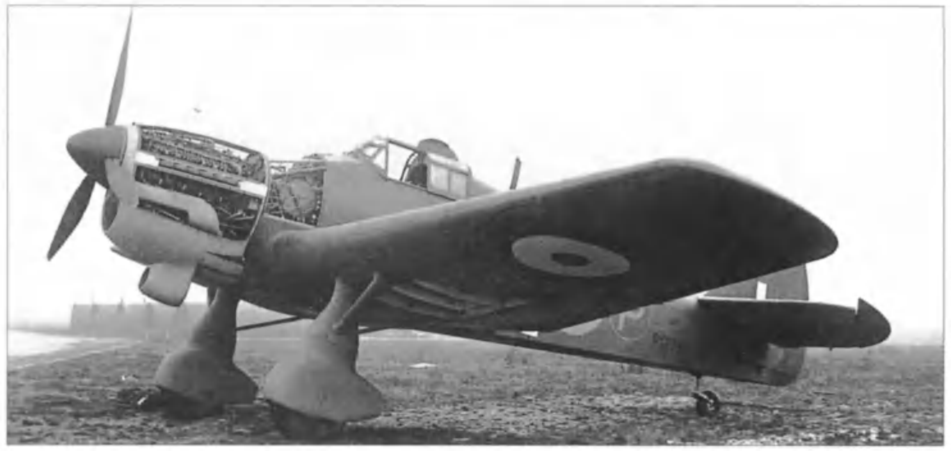
Turret Fighter Project to F.9/35, 4.8.35.
Albacore Torpedo bomber designed originally to M.7/36. First flown 12.12.38.
Medium Bomber Project to P.13/36, late 1936.
Torpedo Bomber Project believed proposed to S.30/37, 1938.
Heavy Bomber Design to B.1/39, 4.39.
Naval Fighters Designs proposed to N.8/39 and N.9/39, 8.39 onwards. Single-seater (to NAD.925/39) 12.39. Work eventually resulted in Firefly first flown 22.12.41.
Fulmar Two-seat FAA fighter to O.8/38 first flown 4.1.40.
Barracuda Torpedo bomber to S.24/37 first flown 7.12.40.
Night Fighter Project proposed to F.18/40, late 1940.
Close-Support Bomber High-wing monoplane project to B.20/40, late 1940.

Note: *During 1940 Fairey also worked on a twin Wright Cyclone-engined bomber, a single-seat fighter/bomber, a twin Merlin bomber [possibly to B.7/40] and a twin-engine dive bomber/fighter. In 1941 work proceeded on a single-seat cannon fighter with Fairey P.24 pusher engine, in late 1942 single-engine Barracuda 'replacements' were being considered with Sabre, Griffon or P.24.)*

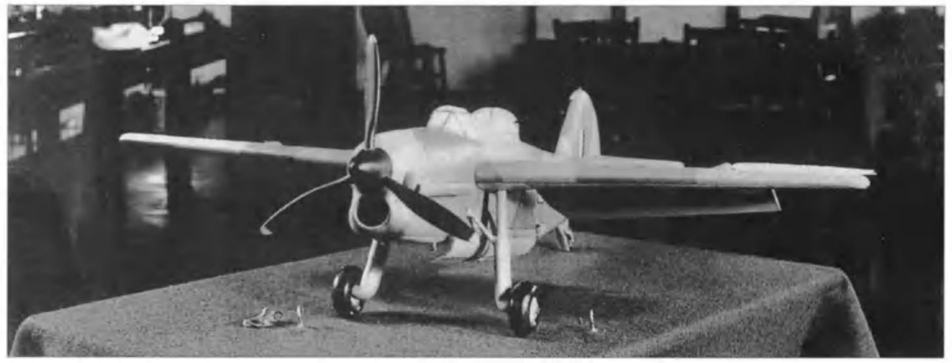
Firefly Development Single-seat Firefly for FAA with 1,850bhp (1,380kW) Centaurus CE.3.SM and alternative single or contra-rotating propellers. Brochure dated 26.7.41 added 750lb (3.3kN) jet for all-up-weight 12,400lb (5,625kg), top speed 343mph (552km/h) at 10,000ft (3,048m), 4.4 minutes to 10,000ft and 590 miles (949km) range.
Barracuda Development Installation of Griffon or Hercules studied second half 1941. Brochure for Barracuda with 1,560bhp (1,163kW) Hercules X 31.1.42, all-up-weight 12,025lb (5,455kg), maximum 259mph (417km/h) at 4,000ft (1,219m), 3.6 minutes to 5,000ft (1,524m).
Torpedo/Recce Aircraft Twin-Merlin project with special hinged engine mountings interconnected with wing fold gear. When wings folded, propeller spinners swung towards each other enabling aircraft to fold within 18ft (5.49m) width, despite engine centres 14ft 8in (4.47m) apart and prop diameter 12ft (3.66m).
Torpedo Bomber Twin Merlin project, 8.4.42. Revised with Griffons 12.7.42.
Torpedo Bomber Reconnaissance Aircraft Study to S.6/43, 4.43.
Dive/Torpedo Bombers Series of designs to O.5/43, 4.43 onwards. Resulted in Spearfish first flown 5.7.45. Proposed Clyde test bed conversion 18.4.45.
Naval Fighter Design studies to N.7/43, 24.4.43 onwards.
Naval Bomber Combined piston/jet project to S.11/43, mid-1943.
Firefly Development Single-seat fighter with 1,640bhp (1,223kW) Griffon 71 and 780lb (3.5kN) jet, 18.8.43. All-up-weight 13,250lb (6,010kg), maximum (using jet) 428mph (689km/h) at 20,000ft (6,096m), 3.2 minutes to 10,000ft (3,048m), 162nm (261km) range.
Single-Seat Fighter Preliminary studies into machine using Firefly components, early 1944. Alternative RR Pennine or Griffon engine.
Strike Aircraft Spearfish developments to O.21/44 with different engine arrangements, 7.44 onwards. Various development proposals with different engines.
Strike Fighter Twin tandem engine studies from 8.44. Turboprop developments from mid-45. Three prototypes ordered to N.16/45 but not built. Programme replaced by Gannet.
Gannet Various studies for anti-submarine aircraft to GR.17/45. First brochure 14.12.45. As Type Q became Gannet, first flown 19.9.49.

FOLLAND

Fo.100 Believed to be a bomber powered by a single Vulture, 4.37.
Fo.100A Bomber with one Vulture, 8.37.
Fo.101 Fighter with twin Alvis Pelides engines, 4.37.
Fo.102 Vulture-powered interceptor, 4.37.
Fo.104 Torpedo spotter reconnaissance (TSR) type with two Aquila engines, 7.37.
Fo.107 Sabre-powered interceptor, 4.38.
Fo.108 Test bed aircraft to 43/37 (Folland 'Frightful') first flown 1940. Used to test different versions of Bristol Hercules and Centaurus, Napier Sabre and RR Griffon, plus various propellers.
Fo.111 Single-engined bomber project, 1939/40.
Fo.111A Bomber with single Pratt & Whitney Twin Wasp radial, 1.40.
Fo.112 Unarmed bomber, single Wasp or Sabre, 1.40.
Fo.112A Single Sabre unarmed bomber, 9.40.
Fo.113 Twin-engine two-seat bomber to B.1/40, 1940/41.
Fo.114 As Fo.113 but powered by two Griffons, 1940/41.
Fo.115 Sabre-powered 'torpedo reconnaissance' aircraft to E.28/40, 1941.
Fo.116 As Fo.115 but variable-incidence wing and 2,400hp (1,790kW) Centaurus III, 1941. E.28/40 called for research aircraft to examine problem of increasing weight during carrier deck landings and prototypes DX160 and DX165 ordered 8.41 with Centaurus replacing Sabre. Variable incidence (range between -1° and +14°) would allow pilot to keep fuselage horizontal throughout landing while wing also had leading edge slots and Fowler trailing-edge flaps for maximum lift. Initial estimates suggest span 51ft 2in (15.6m), length 43ft 0in (13.1m), wing area 380ft^2 (35.3m^2), top speed 292mph (470km/h), all-up-weight 18,250lb (8,278kg) which, without the special wing, would have given minimum speed too high for carrier landing. By 1943 DX160 well advanced but by then many of problems to be examined were solved, so project cancelled. DX165 never started.
Fo.116A As Fo.116 but different engine, 3.42.
Fo.117 Single-seat fighter to F.6/42, 4.9.42.
Fo.117A Revised Fo.117 with laminar flow wing, 2,500hp (1,864kW) Centaurus 12 and contra-rotating propeller. To be built by English Electric. Six examples, RD104, RD107, RD108, RD113, RD115 and RD118, ordered 10.9.43 but never built. Variant fitted with single jet engine not given project number, 12.43.
Fo.118 Single-seat naval fighter adapted from Fo.117 to N.7/43, 5.43.
Fo.119 Single-engine dive bomber to O.5/43, 6.43.



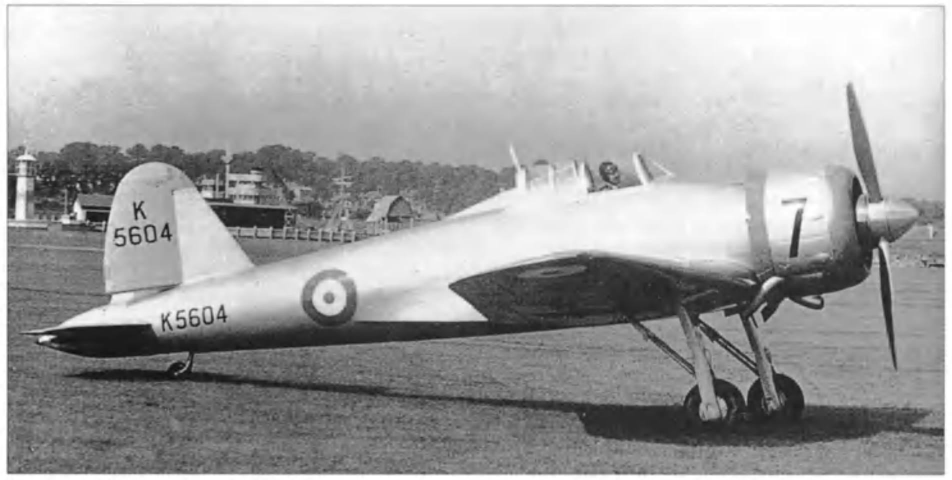
View of the Folland 'Frightful' engine test bed with Napier Sabre and Bristol Hercules units installed. Eric Morgan



Model of the Folland Fo.116. Peter Green

N5525
N5525

Britain's last biplane fighter was the Gloster Gladiator. N5525 was a Sea Gladiator Mk.1 and its retracted arrester hook is clearly visible.



Gloster F.5/34 prototype K5604.

Handley Page Hampden Mk.1 L4159.

GENERAL

GAL.28 High-speed aircraft to 35/35, 1936.
GAL.39 Covered two torpedo bomber projects, GAL.39a and b, to S.30/37, 1938.
GAL.43 Covered two engine test bed projects, GAL.43a and b, to 43/37, mid-1938.
GAL.46 High-altitude fighter to F.4/40, 18.10.39. Revised c9.40.

GLOSTER

The P numbers here list drawings, not projects, so many of the 'gaps' belong to drawings of the same aircraft showing internal detail, etc, and not different designs.

Gladiator RAF's last biplane fighter built to 14/35. Prototype SS.37 first flown 12.9.34.
G.38 Single-seat fighter to F.5/34 first flown 5.36.
Turret Fighter Work done to F.5/33 and F.9/35 culminated in order to F.34/35 (serial K8625) in 1935. Work replaced by design to F.9/37, became single-seat G.39 (no turret) first flown 3.4.39.
Heavy Bomber Project to B.1/35, 6.35.
Reconnaissance Bomber Project to G.24/35, late 1935.
High-Speed Aircraft Design to 35/35, 1936.
Turret Fighter Design to F.11/37, mid-1937. Bomber F.11/37 also proposed with Hercules engines, 1937.
High-Speed Fighters Two twin-boom and one twin-engine design to F.18/37, 1938.
Heavy Bomber Project to B.1/39, 4.39.
Naval Fighters FAA fighter to N.8/39 and turret fighter to N.9/39, c.8.39. Single-seat development (to NAD.925/39) 12.39.
G.40 Pioneer Research aircraft to E.28/39 and Britain's first jet flown on 15.5.41.
G.41 Meteor Britain's first jet fighter to F.9/40, flown 5.3.43.
Night Fighter Development of F.9/37 to F.18/40, c11.40. Design further developed into single-seat heavy fighter 1940/41.
P.109 First 'Gloster Jet Bomber' proposal with four Whittle W2B jets in individual pods 12.8.41 (drawing number unknown). Modified P.109 produced 24.11.41 with engines podded in pairs.
G.A.1 Jet fighter to E.5/42, early 1942 onwards. Mock-up and components produced before abandoned 1944 and replaced by G.A.2.
P.147 Gloster F.9/40 with de Havilland Halford engine, c7.43.
P.148 Gloster F.9/40 with MetroVick engine, c7.43.
P.150 Rocket E.5/42 development with two Rolls B.37 Derwent I or B.38 engines in fuselage behind pilot, 7.43.
P.171 & P.172 Single Halford engine projects bridging gap between E.5/42 and E.1/44 fighters, late 1943.
P.173 Meteor Mk.I with RR W2B/37 propeller combination installation, 13.1.44. Became 'Trent Meteor' powered by Trent turboprop and first flown 20.9.45.

Formation of Handley Page Herefords, the nearest appears to be L6090.

P.174 P.171/P.172 development with H.2 engine, 26.1.44.
P.175 Further development of P.174, 3.3.44.
P.181 Development of G.A.1 to E.1/44, Halford H.2 engine, 2.7.44.
P.190/G.42/G.A.2 Ace P.181 with B.41 (Nene) engine, flown 9.3.48. Name little used.
P.199 AJ.65 (Avon) powered version of E.1/44, 1945.
P.203 Meteor high-altitude aircraft with RR Derwent 5, 30.1.46. Greater span wings with square tips.
P.209 Twin-jet fighter with two RR AJ.65 (Avon) engines, 25.6.46.
P.212 G.A.2 Ace third prototype fitted with tail high on fin, 2.9.46, flown 1949. Tail later adopted for Meteor F Mk.8.
P.213 F.23/46/P jet fighter with one Nene, 30.8.46. Shorter wingspan than P.212.
G.47 Meteor Night Fighter. Full prototype to F.24/48 first flown 31.5.50. Design and production assumed by Armstrong Whitworth.

HANDLEY PAGE

A company that, from a warplane point if view, concentrated entirely on bombers.

HP.52 Hampden bomber to B.9/32 (Bristol Pegasus engines) first flown 21.6.36.
HP.53 Hereford development of Hampden to 44/36 (Napier Dagger engines) first flown 6.10.38.
HP.54 Harrow bomber transport first flown 10.10.36.
HP.55 Heavy bomber to B.1/35 with two Hercules or Merlin, 6.35.
Torpedo Bomber Conversion of HP.52 to M.15/35, late 1935.
HP.56 Medium bomber to P.13/36 with twin Vultures, 1.1.37.
High-Speed Bomber Unnumbered project for unarmed high-speed bomber, 5.37.
HP.57 Heavy bomber with four Merlin X, 8.37. Became Halifax Mk.I first flown 25.10.39.
HP.58 Heavy bomber project intended to be (first) Halifax Mk.II, 1939. Had dorsal and ventral turrets mounting 20mm cannon and four Merlin X. L7244 earmarked for conversion as a prototype but work suspended autumn 1940. Project never left drawing board through problems developing turrets but mock-up inspected 12.39.
HP.59 Halifax Mk.II as built.
HP.59A Half-scale B.1/39 project with four Pobjoy Niagara V engines, 1940.
HP.60 Heavy bomber to B.1/39, 4.39.
HP.60A Halifax IV with Merlin 60 engines, c1940.
HP.61 Halifax III with Hercules VIs first flown 10.42. Also covered Halifax VI and VII.
HP.62 Hampden II medium bomber project with twin Wright Cyclone G.102 engines, 1941.
'75 Ton Bomber' Three designs, one conventional, two with canards including one powered by jets, 14.1.43.
HP.63 Halifax Mk.V with Merlin 22 engines, 1943.
HP.65 Development of Halifax IV ('Super Halifax') with Hercules 38s B.14/43, 6.43.
HP.66 'Stretched' Halifax with Hercules 100 turbo-blower engines to B.27/43, 15.11.43. Proposed as alternative to HP.65. To be called Hastings B Mk.1 and prototypes ordered, but cancelled 4.44 and name transferred to HP.67 transport.
HP.69 Hastings B Mk.II bomber project with four Hercules HE.15.MT, 11.43.
HP.75 Experimental Manx tailless aircraft with two DH Gipsy Major II engines and built by Dart Aircraft at Dunstable in 1939. First flown 25.6.43. No project number until 1945.

HAWKER

One of the most famous of fighter firms, Hawker rarely forayed into bomber development. The P.1000-series of project numbers was introduced in 1940 but, at the time of writing, drawings for most of the projects listed up to P.1050 have not been traced and may no longer exist. Even into the war, not every project received a number.

Henley Light day bomber to P.4/34 first flown 10.4.37.
Hurricane Single-seat fighter to F.36/34 first flown 6.11.35.
Hotspur Day and night turret fighter to F.9/35, 9.8.35. First flown 14.6.38.
Single-seat Fighter Project based on Hurricane tendered to 35/35, 21.2.36.
Day and Night Fighter Hurricane with four Oerlikon cannon to F.37/35, 23.4.36.
Medium Bomber Project with two Vultures to P.13/36, 1.1.37.
Turret Fighter Two-seat twin-engine fighter to F.11/37 tendered mid-1937.
Tornado Single-seat high-speed fighter with Vulture to F.18/37. First flown 6.10.39.
Typhoon Single-seat fighter with Sabre to F.18/37. First flown 24.2.40.
Torpedo Bomber Project to S.24/37, 3.3.38.
Fleet Fighters Fixed-gun naval fighter to N.8/39 and turret fighter to N.9/39, c8.39. Single-seat project (NAD.925/39) 12.39.
Fighter Single-seat fighter with Griffon and two 40mm guns, schemed 1939.
Tornado Test Beds Preliminary schemes to fit alternative engines to Tornado – Bristol Centaurus (1939), Duplex Wright Cyclone (1940/41) and Fairey Monarch (1940). Tornado prototype flown with Centaurus 23.10.41.
P.1000 Single-seat fighter with single shaft-drive Sabre and contra-rotating propellers, 1940.
Typhoon Development Proposal to fit wing with six cannon, 1940. Set of wings built.
P.1001 Close-support bomber based on Henley to B.7/40, 1940.
P.1002 20mm cannon installation for Hurricane Mk.IIc, 1940.
Henley Development Two-seat long-range fighter variant, 1940. Design extended to bomb bay tanks only.
P.1003 Escort fighter conversion of Henley, 1940.
P.1004 Two-seat high-altitude fighter (Typhoon scaled up by 25%) to F.4/40, c9.40.
P.1005 Twin-engined high-speed bomber with Sabre engines to B.11/41, 12.40. Fighter variant also prepared.
P.1006 Henley-based close-support bomber to B.20/40, late 1940.
P.1007 Single-seat high-altitude fighter, 1940.
P.1008 Night fighter to F.18/40, 1940.
Hurricane Floatplane Proposed conversion, 1940. Cancelled.
Hurricane Development Variant with Griffon, 1940. Abandoned 1941.
P.1009 Fleet fighter based on Typhoon to N.11/40, c2.41.
P.1010 Typhoon with turbocharged engines, 1941.
P.1011 P.1004 fitted with Power Jets engine, 1941.
P.1012 Typhoon Mk.2 fitted with leading edge radiators to F.10/41, 1941. Became Tempest Mk.1 flown 24.2.43. Tempest Mk.V with Sabre and chin radiators first flown 2.9.42.
P.1013 P.1005 fitted with remotely-operated guns, 1941.
P.1014 Single-seat fighter with one Power Jets engine, 1941.
P.1015 P.1005 fitted with Centaurus engines, 1942.
P.1016 Typhoon Mk.II with Griffon, 10.4.42. Became Tempests III and IV but not built.
P.1017 Single-seat fighter with Griffon and Typhoon wings, 1942.
P.1018 Light fighter with Sabre 43 to F.6/42, 14.9.42.
P.1019 Light fighter with Griffon 61 to F.6/42, 14.9.42.

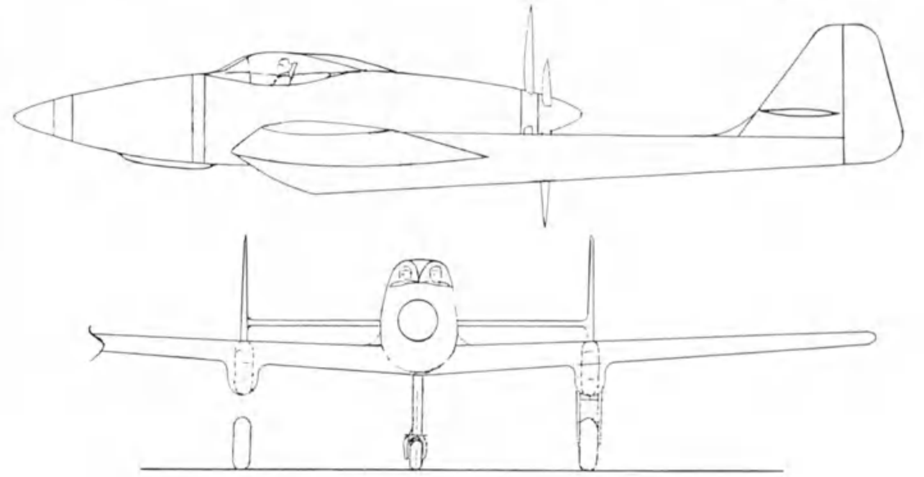
P.1020 Light fighter with Centaurus to F.6/42, 14.9.42. Formed basis of Fury Mk.I and flown 1.9.44.
Tempest Variant Scheme to fit 0.5in (12.7mm) machine guns, 1942.
P.1021 Tempest with Centaurus to F.6/42, 1942. As Tempest Mk.II first flown 28.6.43.
P.1022 Naval fighter to N.7/43, 1943. Became Sea Fury Mk.X first flown 21.2.45.
P.1023 Tempest I with Sabre IV tendered 1943.
P.1024 Tempest development with Sabre V, 1943. Not tendered.
P.1025 Light fighter with Griffon tendered 1943.
P.1026 Fighter to F.2/43 with Griffon, 1943. Built as LA610 and flown with Griffon 85 27.11.44. Later fitted with Sabre VII and flown 3.4.46.
P.1027 Tempest with RR.46 Eagle engine, 1943. Not tendered.
P.1028 Tailless fighter, 1943. Scheme only, not tendered.
P.1029 Tail-first fighter, 1943. Scheme only, not tendered.
P.1030 Fighter with '4,000hp' (2,983kW) Eagle, 11.9.43. Basic design and data completed but not tendered.
P.1031 Fighter based on Fury with RR B.40 jet in nose, 1944.
P.1032 P.1026 fitted with Eagle to F.2/43, 1944.
P.1033 P.1005 fitted with two Eagle engines, 1944.
P.1034 P.1005 fitted with RR B.41 (Nene) jet engines, 1944.
P.1035 P.1026 fitted with B.41 (Nene) jet amidships to F.2/43, 1944. Air intakes in wing and split jet exhaust pipe.
P.1036 Private venture scheme for P.1026 fitted with Sabre V, 1944.
P.1037 Twin-boom fighter with two Griffons, 1944. Not tendered.
P.1038 Variant of P.1034 fitted with two B.41 (Nene), 1944.
P.1039 Variant of P.1034 fitted with two fuselage-mounted B.41 (Nene) jets, 1945.
P.1040 Variant of P.1035 with 'Tempest' wing replaced by new design, 12.44. Prototype first flown 2.9.47 and became Sea Hawk.
P.1041 Design investigation into Mosquito replacement, 1944/45.
P.1042 Variant of P.1040, 1945.
P.1043 P.1040 with undercarriage removed for landing on flexible decks, 1945.
P.1044 Scheme for naval fighter bomber, 1945.
P.1045 Fighter version of P.1040 with Rolls-Royce AJ.54 engine, 7.45.
P.1046 P.1045 project fitted with rocket boost, 1944/45. P.1040's straight wing replaced by alternative with moderate sweep and high taper.
P.1047 P.1046 fitted with highly swept wings, rocket boost and one B.41 engine, 1945.
P.1052 Swept-wing experimental development of Sea Hawk. First flown 19.11.48.

MARTIN-BAKER

MB.2 Single-seat fighter to F.5/34 flown 3.8.38.
Twin-engine Fighter Unnumbered private venture project to 35/35 with twelve machine guns in nose, 1936.
MB.3 Single-seat fighter to F.18/39 flown 3.8.42.
MB.4 Unbuilt development of MB.3 with Centaurus, 1942.
Tankbuster Unnumbered twin-boom design for ground attack, 24.3.43.
MB.5 Single-seat fighter to F.18/39, final development of MB.4, flown 23.5.44.
Twin-Boom Fighter Two-seat low-wing monoplane, c1944/45. Two Griffons mounted in nose and rear fuselage, each with two three-blade contra-rotating airscrews. Fuselage and wing structure probably identical to Martin-Baker steel tube structure skinned with stressed light alloy, as used on MB.5. Fixed incidence tailplane and elevator, main wheel housed in wing booms, side-by-side seating. Span 53ft 0in (16.2m), length 51ft 8in (15.7m), no performance data available.
MB.6 Single-engine low-wing fighter with four 20mm Hispano cannon, c1945. Cigar shape fuselage with nose intake, all-metal stressed skin construction, tailplane and elevator positioned on top of aft fuselage. Two skids fitted in lieu of optional tricycle undercarriage. Engine unspecified and no performance figures available. Length 36.25ft (11.0m), wing area 263ft^2 (24.5m^2).
Jet Fighter Experimental twin-boom design with one RR Derwent in nose and another in rear fuselage, c1945. All-metal stressed skin wing structure with all-metal fins and rudders, cigar-shaped fuselage with nose intake for forward engine plus side intakes to rear fuselage unit, tandem seating. Length 51ft 0in (15.5m), no data.

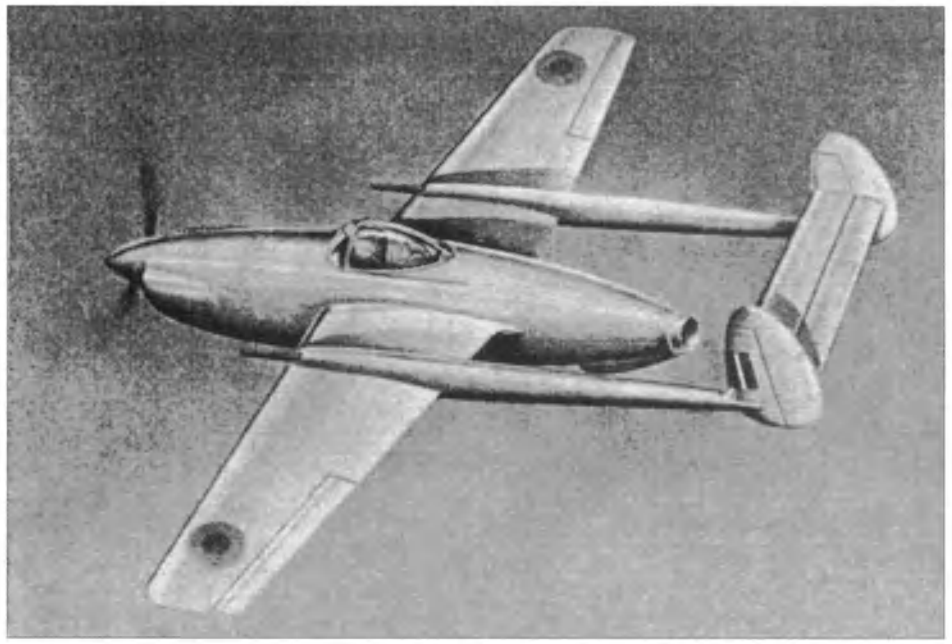
MILES (Phillips & Powis up to October 1943)

M.20 Attempt to address urgent need for fighters in mid-1940. Had all-wood and fixed undercarriage, one Merlin XX and eight machine guns in wings. Specification F.19/40 issued to cover proposal and prototype AX834 designed, built and flown (on 14.9.40) in quick time. RAF success in Battle of Britain ended need for such aircraft. Some in Air Staff considered performance not good enough for day use and armament inadequate for day or night use. Second prototype DR616 built to naval spec. N.1/41.
M.22 Highly streamlined single-seat fighter with two 1,600hp (1,193kW) Griffons, 1941. Miles expected aircraft to achieve 504mph (811km/h) at 15,000ft (4,572m). Wood construction except for metal wing spars, pilot housed in front of centre section to reduce frontal area to minimum. Engines in underslung nacelles, twin fins (at tips of tailplane), 'gun nest' with ten 0.303in (7.7mm) machine guns fitted in leading edge of wing centre section ahead of cockpit. Span 39ft (11.9m), length 33ft (10.1m), wing area 325ft^2 (30.2m^2) all-up-weight 13,000lb (5,897kg), service ceiling 37,000ft (11,278m). Submitted to MAP but not ordered.
M.22A Two-seat night fighter development of M.22 to F.18/40, late 1940.
M.23 High-speed single-seat fighter with single Merlin, 1941. Wood construction except for metal wing spars, low windscreen and canopy to reduce frontal area, elliptical wing, eight 0.303in (7.7mm) machine guns or two 20mm cannon. Intended to fit Griffon later.



Unnumbered Martin-Baker twin-boom fighter (c1944/45). Martin-Baker

Miles M.20.



Miles M.58 composite naval patrol fighter.

Span 31ft (9.4m), length 28ft 8in (8.7m), wing area 185ft^2 (17.2m^2), all-up-weight (Merlin) 6,200lb (2,812kg), (Griffon) 7,400lb (3,357kg). Performance: Merlin (Griffon) top speed 411mph (661km/h) at 17,750ft (5,410m) (470mph [756km/h] at 15,000ft [4,572m]), service ceiling 26,000ft (7,925m) (38,000ft [11,582m]).

M.23A Pressurized high-altitude fighter intended to deal with types such as Junkers Ju 86, 1942. One Merlin 60, two 20mm cannon, first Miles project with thin high aspect ratio wing. Span 50ft (15.2m), length 31ft (9.4m), wing area 262ft^2 (24.4m^2), all-up-weight 7,440lb (3,375kg). Maximum 440mph (708km/h) at 30,000ft (9,144m), service ceiling 45,000ft (13,716m).

M.34 Project design for twin-Merlin aircraft to undertake both ground attack and target tug duties, 1941. Latter task eventually fulfilled by Miles M.33 Monitor. Heavily tapered wing had large root fillets and narrow fuselage. One or two crew dependent on role, proposed four 40mm cannon armament heaviest for any aircraft so far. Design never completed due to company's workload.

M.35 Libellula aerodynamic research aircraft fitted with de Havilland Gipsy Major I pusher engine. Flown 1.5.42 with Class B serial U0235.

Naval Fighter Project with Libellula wing arrangement and single pusher engine, 1942.

M.39 Libellula high-speed high-altitude medium bomber to B.11/41, 7.42. M.39B scale model flown 22.7.43 but full size M.39 never completed.

Heavy Bomber Unnumbered project with Libellula wing arrangement, c5.42. Miles stated Libellula concept, with forward ('canard') wing contributing to lift, would give bomber with same overall dimensions as existing types but much greater bomb load. Six Centaurus CE.3.SM, (two mounted on smaller forward wing, four on rear main wing), tip and central fins, nose, dorsal and rear turrets. Total wing area c2,700ft^2 (251.1m^2), all-up-weight c150,000lb (68,040kg), normal bomb load 51,000lb (23,134kg).

M.42 Ground attack fighter proposal to unnumbered Air Staff requirement, 8.42.

M.43 Ground attack fighter proposal to unnumbered Air Staff requirement, 8.42.

M.44 Ground attack fighter proposal to unnumbered Air Staff requirement, 9.42.

M.52 High-speed experimental aircraft to E.24/43. First attempt to build aircraft to fly faster than sound. First flight planned 1947, project cancelled 3.46.

M.58 Very small naval patrol fighter with mixed piston/jet powerplant, c1945. Possible seven hour patrol at low speed with jet shut down, top speed for combat of 463mph (745km/h) with both engines running. Piston engine 500bhp (373kW), jet 2,000lb (8.9kN) thrust.

PARNALL

Heavy Bomber Proposal with twin booms and no supporting tailplane or structure between them, 1938.

Heavy Fighter Proposal c1938 believed to have been developed into Type 381.

381 Gunnery research aircraft 9.38. Concept from Nash & Thompson after growing interest in equipping aircraft with gun turrets, particularly F.11/37 specification (used as basis for this project). Turret-mounted in fuselage between wings, either above or beneath fuselage, with two 2lb (0.61kg) or 0.5lb (0.15kg) guns or two 20mm cannon; used predictor gun sight. Primarily all-metal structure but some parts in wood. Twin 1,550hp (1,156kW) Hercules HE.6.SM, span 63ft 6in (19.4m), length 61ft 3in (18.7m), wing area 735ft^2 (68.4m^2), gross weight 20,700lb (6,309kg), maximum speed (upper turret and full load) 297mph (478km/h) at sea level, 341mph (549km/h) at 30,000ft (9,144m) (MAP estimated 309mph [497km/h] at that height). Six aircraft order quashed by Wilfrid Freeman 6.2.40 because he was 'not satisfied that Parnall could build this aircraft satisfactorily', or be ready within two years.

PERCIVAL

P.26 Two projects, P.26 and P.26a, proposed as engine test beds to 43/37, mid-1938.

SAUNDERS-ROE

Saro was a flying boat specialist.

A.33 General purpose flying boat to R.2/33 begun as project P.937 and first flown 14.10.38. Damaged on take-off 25.10.38 and never flown again.

S.36 Lerwick flying boat to R.1/36 begun as project P.970 and first flown early 11.38.

P.1036 Single Bristol Mercury-engined flying boat amphibian monoplane with engine pod mounted above fuselage and extended aft to house gun turret and carry tail surfaces, 1939 to 1941. Weight 9,500lb (4,309kg); known as 'Scheme A'.

P.1037 'Scheme B' alternative to P.1036 with conventional central float, 1939 to 1940.

A.37 Shrimp scale model aircraft for S.38 design first flown early 10.39.

S.38 Large flying boat to R.5/39, mid-1939. Initial work to R.3/38, 1938. Later S.38A fitted with Centaurus engines, 4.40.

S.39 (P.1031) Flying boat project, 4.40. Revised to R.14/40, mid-1940. S.39A (P.1034) had retractable planing bottom.

S.41 Flying boat to R.14/40, 1.41 onwards.

S.42 Large flying boat, 1942 to 1943. Used wing of Avro Lancaster bomber and four Merlin XX. All-up-weight 70,000lb (31,752kg).

P.103 Swept-wing variant of SR.A.1 boat fighter, c1947. Nose intakes flanked radome.

P.104 Maritime flying boat to R.2/48, early 1949. Project became P.162. Work continued until about 1956 but never flown.

P.105 Military flying boat with pylon-mounted wing, 1951. Two Centaurus 171, weight 50,000lb (22,680kg).

P.106 Mixed powerplant military flying boat, 1949 to 1951. Two versions, both with four engines. First had V-tail, two compounded Griffon and two Nene – span 134ft (40.8m), weight 81,000lb (36,742kg). Second twin booms and tail floats, two Napier Nomad and two AS Sapphire – span 135ft (41.1m), weight 90,000lb (40,824kg).

P.110 Princess civil flying boat proposed as reconnaissance bomber, 1950.

P.113/SR.44/SR.A.1 Experimental flying boat fighter to E.6/44, flown 16.7.47.

P.114/SR.44 Long jet pipe version of P.113 rejected in favour of that project's twin pipes, 1.44.

P.122 Larger, faster and more heavily armed SR.A.1, 10.50. Reheated AS Sapphire, swept wings, cheek intakes, nose radome, four 30mm Aden. Span 46.4ft (14.1m), length 51ft (15.5m).

P.162 Long-range reconnaissance and anti-submarine flying boat, 1952-56.

SHORT BROTHERS
(from 1943 Short Brothers & Harland)

Shorts had a big reputation for building flying boats. Many pre-war and wartime Shorts project drawings were lost during the conflict so relatively little now survives on the company's project work from that period. The P.D-series relates to post-1947 projects from Belfast.

Flying Boat Design tendered to R.1/36, mid-1936.

S.25 Sunderland flying boat built to R.2/33 and first flown 16.10.37.

S.29 Bomber to B.12/36, became Stirling, first flown 14.5.39. Version proposed with cannon turrets, 1939.

Medium Bomber Project to B.1/36, 1.37.

S.31 M.4 half-scale Stirling replica with Pobjoy engines flown 19.9.38.

S.34 Cannon-armed bomber to B.1/39, 4.39.

Flying Boat Design tendered to R.5/39, mid-1939.

S.35 Flying boat to R.14/40, late 1940/early 1941. Shetland built to R.14/40 Issue II, first flown 14.12.44.

S.36 Super Stirling to B.8/41, 7.41 onwards.

'75 Ton Bomber' Three version of basic design, 1.43.

S.38 Naval torpedo bomber and recce aircraft proposals to S.6/43, mid-1943. Specification amended to S.11/43, first flown as S.A.1 Sturgeon 7.6.46.

S.41 S.A.3 jet fighter, possibly produced to N.7/46, c1946. Possibility is 'Jet Sturgeon' night fighter.

S.45 S.A.6 Seaford flying boat development of Sunderland built to R.8/42 and first flown 30.8.44.

P.D.2 Maritime flying boat to R.2/48, early 1949. Two designs proposed, one based on Shetland, one all-new.

VICKERS-ARMSTRONGS

Vickers allocated project numbers to individual prototypes, to production runs and to unbuilt designs. All relevant numbers are included here for completeness.

249 Not allocated to a specific type. The '249' series of Vickers drawings (24901 to 24999) embraced most of the company's unbuilt projects from the early 1930s to towards the end of WW2 and included fighters (F.9/35, F.22/39, etc), bombers (B.12/36, P.13/36, B.1/39, 6-engine, etc) and other types. Separate project numbers were still allocated to some of the designs.

271 Bomber to B.9/32. Prototype first flew 15.6.36 and aircraft entered service as Wellington.

Turret Fighter Design to F.9/35, 9.8.35.

Torpedo Bomber Conversion of Type 271 to M.15/35, late 1935.

279 Single-seat Venom fighter first flown 17.6.36.

284 Bomber to B.1/35 with two Vulture, 6.35. Became Warwick prototype K8178 first flown 13.8.39.

285 Wellington Mk.I prototype L4212.

290 Wellington Mk.I production aircraft.

293 Heavy bomber to B.12/36, 9.36.

Medium Bomber Warwick development to P.13/36, late 1936.

298 Wellington Mk.II prototype L4250.

299 Wellington Mk.III prototype L4251.

400 B.1/35 (Warwick) proposal with Sabre schemed for K8178, c1938.

401 B.1/35 (Warwick) with Centaurus CE.1.SM. Prototype L9704 first flew 5.4.40.

403 Wellington for New Zealand.

405 Heavy bomber to B.1/39, 4.39.

406 Wellington Mk.II production aircraft.

407 Wellington Mk.V prototype pressure cabin high-altitude second prototype.

408 Wellington Mk.IA production aircraft.

409 Wellington Mk.IB scheme for development.

410 Wellington Mk.IV serial R1220.

411 Production B.1/35 Warwick with RR Vulture II (design only), c1939.

412 Wellington Mk.IA production for New Zealand.

413 B.1/35 Warwick Mk.II with Centaurus IV, serial BV216.

414 Fighter project to F.6/39, 6.39. Specification replaced by F.22/39 and project modified. Also night fighter developments to F.18/40, 10.40 and 1.41.

415 Wellington Mk.IC production.

416 Wellington Mk.II L4250 with 40mm gun.

417 Wellington Mk.III production

418 Wellington DWI Mk.I serial P2516.

419 Wellington DWI Mk.II L4356.

420 Fighter project to F.16/40, 1940.

421 Wellington high-altitude Mk.V first prototype R3298 to B.23/39. First flown September 1940.

422 Proposed production for Warwick Mk.II with Pratt & Whitney R-2800 Double Wasp engines.

423 All marks of Wellington modified to carry 4,000lb (1,814kg) bomb.

424 Wellington Mk.IV production.

425 Special bomber with six Merlin HA engines.

High-Altitude Bomber Six-engine bomber project, 1.41 to 1.42.

426 Wellington Mk.V.

427 Warwick Mk.I conversion with Double Wasp engines, serial L9704 converted.

428 Wellington DWI Mk.III P9223.

429 Wellington Mk.XVIII production aircraft.

430 Wellington Mk.VII serial T2545 (cancelled).

431 Pressure cabin Wellington Mk.VI prototype W5795.

432 Cannon fighter to F.7/41. First flown 24.12.42.

High-Speed Medium Bomber Several designs based on B.11/41 and Bristol Buckingham requirements, 4.42 onwards.

433 Pressure cabin Warwick Mk.III with four Merlin 60s to B.5/41, mid-1941.

434 Wellington with two Bristol Pegasus XVIII.

435 Wellington Turbinlite T2977.

436 Wellington Mk.V R3298 with Hercules XI engines and turbo-blowers.

439 Wellington Mk.II Z8416 with 40mm gun in nose.

440 Wellington Mk.X production.

441 Proposal to licence produce American Boeing B-29 heavy bomber.

442 Pressure cabin Wellington Mk.VI production.

443 Wellington Mk.V W5816 engine test bed.

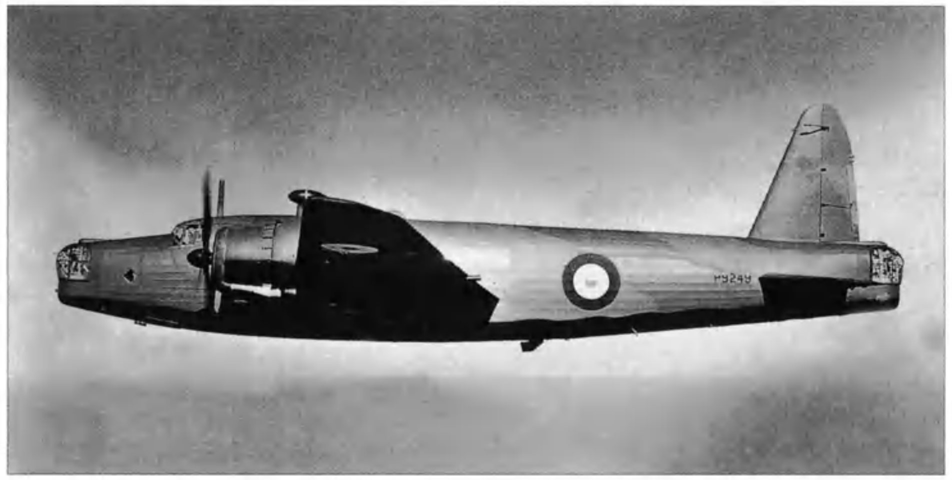
444 Warwick development.

445 Wellington Mk.II engine test bed Z8570 fitted with Whittle W2B/23 jet engine.

446 Cannon fighter to F.7/41. Second prototype serial DZ223, never completed.

447 Windsor prototype DW506 first flown 23.10.43.

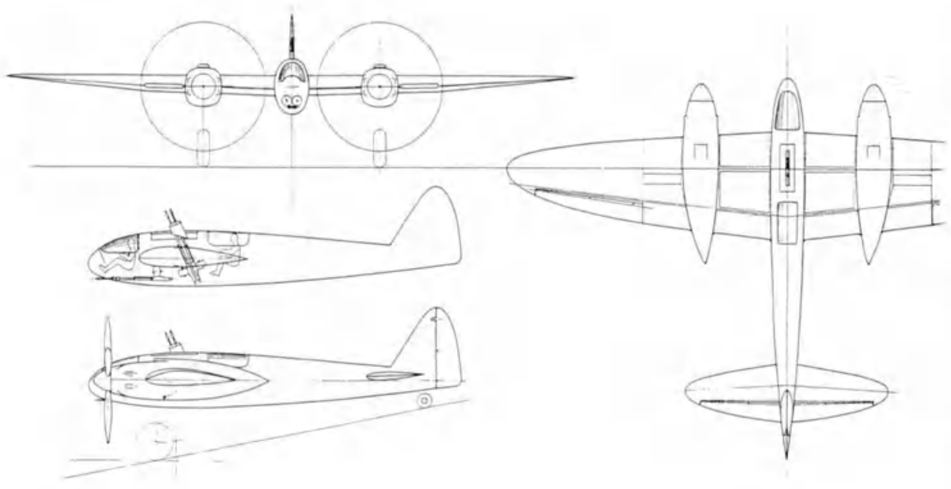
448 Wellington HF616 fitted with single turbo-blower.



Vickers Wellington Mk.IC P9249.

Vickers Venom fighter to F.5/34.

Supermarine 319 (2.9.37). Eric Morgan



449 Wellington VIG – production Type 431 modified.

450 Wellington Mk.II W5518 to be fitted with Whittle W2B/23 jet; cancelled.

451 Wellington Mk.IA test bed aircraft.

452 Wellington Mk.III minelayer serial BJ895.

453 Continuation of project drawing numbers after '249' series filled.

454 Wellington Mk.XI MP502 ASV Mk.II.

455 Wellington Mk.XII Leigh light and ASV Mk.III.

457 Windsor second prototype DW512.

458 Wellington Mk.XI (ASV Mk.III) production.

459 Wellington Mk.XI MP545 trials aircraft.

461 Windsor Mk.III project with Merlin 85.

Single-seat Fighter Unnumbered project to F.6/42, 11.9.42.

'75 Ton Bomber' Five alternative designs submitted 14.1.43. Version of foreplane alternative drawn with six de Havilland jets 4.43.

463 De Havilland Mosquito converted to carry 'Highball' bouncing bomb – prototype DZ471.

464 Production Avro ('Dam Buster') Lancaster converted to carry 'Upkeep' bouncing bomb.

465 Production Mosquito converted to carry 'Highball' bouncing bomb.

466 Wellington GR Mk.XIII (ASV Mk.II) production.

467 Wellington GR Mk.XIV (ASV Mk.III) production.

468 Warwick Mk.I L9704 fitted with nacelle guns.

469 Warwick GR Mk.II production aircraft.

470 Wellington Mk.II W5389 fitted with Whittle jet.

471 Windsor Mk.IV serial NN670 (not completed).

473 Warwick GR Mk.II daytime coastal patrol aircraft.

474 Warwick GR Mk.V night-time coastal patrol aircraft.

475 Wellington engine test bed.

476 Windsor Mk.V NN673 with Merlin 100s.

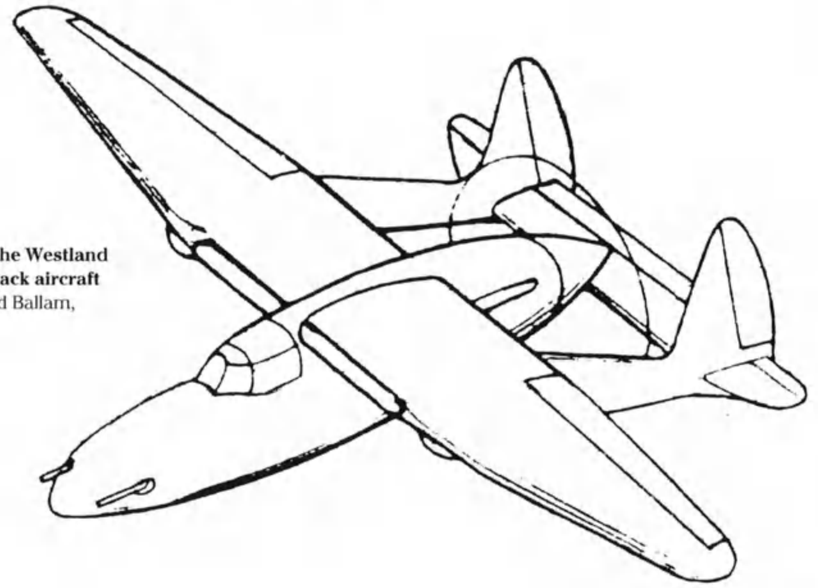
478 Wellington Mk.X LN718.

479 Windsor variant with four Hercules.

480 Windsor Mk.IIA NK136.

481 Wellington variant.

483 Windsor B Mk.1 production aircraft; cancelled.



Sketch of the Westland ground attack aircraft (2.42). Fred Ballam, Westland

485 Warwick ASR Mk.VI production.

486 Wellington Mk.II W5518 fitted with Whittle W2/700 jet.

487 Wellington Mk.XVII service conversions.

488 Mosquito 'Highball' aircraft DZ471 with air turbine.

489 Windsor 'L' special project for large bomber.

490 Wellington Mk.XVIII converted from Mk.XI.

492 Mosquito 'Highball' aircraft; special variant.

494 Windsor B Mk.1 long-range production aircraft; cancelled.

High-Altitude Heavy Bomber Design with four or six RR Clyde engines, 11.44.

Windsor Development Variant fitted with four Griffon, 12.44.

600 Warwick HG341 and HG345 test bed aircraft.

601 Windsor B Mk.2 variant with Clyde. First brochure 1.45. Plans to convert prototype NN673 not completed.

602 Wellington test bed LN715 with two RR Dart turboprop engines.

603 Wellington test bed RP484 for Viking aircraft.

606 Warwick in-flight refuelling aircraft.

608 Wellington project with two Armstrong-Siddeley Mamba engines.

Jet Bomber Unnumbered high-altitude jet bomber project, 3.45.

VICKERS SUPERMARINE

Following Vickers practice, many of the following relate to prototypes and production aircraft rather than projects but they are included to give a full list.

300 Projects leading to Spitfire prototype K5054 (first flown 5.3.36), and initial production aircraft.

305 Two-seat fighter with one Merlin to F.9/35, 16.8.35.

311 Fighter (Spitfire) to F.37/34, 4.36.

312 Spitfire development to F.37/35, 23.4.36.

313 Single-seat fighter with two RR Goshawk B engines to F.37/35, 25.4.36.

314 Flying boat with two Vultures to R.1/36, 26.5.36.

316 Heavy bomber with four Hercules or Merlin and single fin to B.12/36, 30.9.36.

317 Heavy bomber with four Hercules and twin fins to B.12/36, 1.37. Mock-up built and prototypes ordered but destroyed by bombing raid before completed.

318 Heavy bomber with four Merlins and twin fins to B.12/36, 1.37.

319 Two-seat development of F.11/37 fighter with two Vultures, 8.37. Four 20mm cannon, two in lower nose firing forward, two in dorsal position mounted at c65° to fire at target above. Span 56ft 6in (17.2m), length 37ft 6in (11.4m).

322 'Dumbo' torpedo bomber and recce aircraft to S.24/37, 7.3.38. First flown 2.43.

324 Single-seat fighter with twin Bristol Taurus or Merlin tractor engines to F.18/37, 21.4.38.

325 Single-seat fighter with twin Taurus or Merlin pusher engines to F.18/37, 26.4.38.

327 Six 20mm cannon fighter development of F.18/37 project, 26.8.38.

328 Flying boat to R.5/39, 6.39. Initial scheme to R.3/38 (1938).

329 Spitfire F Mk.II production (design 9.38).

330 Spitfire F Mk.III N3927 and W3237 only.

331 Spitfire F Mk.VB.

332 Spitfire with FN gun installation in wings, 4.39.

333 Two-seat fleet fighters with Merlin or Griffon to N.8/39, early 9.39. Single-seat developments of Spitfire (to NAD.925/39) 16.12.39.

334 Fighter to F.6/39, mid-1939. Mock-up only.

335 Spitfire F Mk.I for Greece.

336 Spitfire F Mk.I for Portugal.

337 Spitfire F Mk.IV (DP845 only). Original design brochure dated 4.12.39.

338 Spitfire Mk.I design for Fleet Air Arm, 11.39.

339 Single-seat FAA fighter projects, 12.39.

340 Seafire F Mk.IB prototype and production.

341 Spitfire Mk.I for Turkey.

342 Spitfire Mk.I fitted with Blackburn Roc floats.

343 Long-range Spitfire design, 5.40.

344 Spitfire Mk.I with floats.

345 Spitfire Mk.I design with 13.2mm guns, 5.40.

346 Spitfire Mk.I with 'C' wing and 20mm guns.

Jet Spitfire Jet fighter with new fuselage, H.1 engine and Spitfire wings, 1942.

348 Spitfire F Mk.III second prototype W3237.

349 Spitfire F Mk.VC production aircraft.

350 Spitfire F Mk.VI production.

351 Spitfire F Mk.VII production.

352 Spitfire F Mk.VB tropical variant production.

354 Spitfire development, design 9.41.

355 Spitfire Mk.V Special W3760.

356 Spitfire F Mk.21, 22 and 24 production.

357 Seafire F Mk.IIC production.

358 Seafire F Mk.III production.

359 Spitfire F Mk.VIII design 3.42 and prototype JF299.

360 Spitfire F Mk.VIID and VIII design 3.42 and production.

361 Spitfire F Mk.IX/XVI.

363 Tropical Spitfire design, 5.42.

364 Tropical Spitfire design, 5.42.

Single-seat Fighter Unnumbered Spitfire Mk.21 development to F.6/42, 10.9.42.

366 Spitfire F Mk.XII prototype and production.

368 Heston project for Spitfire F Mk.VIII with Malinowski wing.

369 Spitfire F Mk.XIV (JF316 converted from Mk.VIII).

371 Spiteful with laminar flow wing to F.1/43, 11.42. First flown 30.6.44.

372 Spitfire F Mk.VIII design with semi-laminar wing, 1.43.

373 Spitfire F Mk.XIV DP851 with contra-rotating propeller.

375 Seafire LF Mk.IIC design (2.43) and production.

376 Spitfire Mk.VIII with contra-rotating propeller, 2.43.

377 Seafire F Mk.XV, 3.43. Prototype NS487.

378 Spitfire F Mk.IX design for tropical conditions, 4.43.

379 Spitfire F Mk.XIV (= Mk.VIII with Griffon). Original design brochure dated 5.43.

380 Design of second prototype 'Dumbo' torpedo bomber to S.24/37.

382 Seafang F Mks.31 and 32 design 10.43. First flown early 1946.

383 Spiteful design, 11.43.

384 Seafire F Mk.XVII design (11.43) and production.

385 Spitfire F Mk.IX seaplane MJ892.

386 Seafire F Mk.XV design (11.43).

388 Seafire F Mks.45, 46 and 47 design (11.43.).

391 High-performance fighter with single RR 46H Eagle, 20.3.44.

392 Jet fighter with single B.41 Nene to E.10/44. Prototype first flew 27.7.46. Naval development to E.1/45. Entered service as Attacker.

393 Spiteful F Mk.XIV design, 11.44.

394 Spiteful F (and PR) Mk.XVIII design (11.44) and production.

395 Seafire F Mk.XVIII design 11.44.

396 Seafang F Mk.32 (development of Seafire Mk.XVII) design 11.44.

397 Attacker with folding wings for overseas sales.

398 Attacker F Mk.1 and FB Mk.2 naval prototype and production. Prototype first flown 17.6.47.

500 Revised version of Type 392, c1946.

501 Experimental Spitfire intended for powerplant development.

510 Swept-wing experimental development of Attacker to E.41/46. First flown 29.12.48.

515 Projected Attacker F Mk.2 with DH Ghost II engine, 1947.

516 Attacker variant, c1947.

519 Attacker fitted with jet deflection, c1948/49.

524 Maritime flying boat to R.2/48, early 1949.

527 Proposed Attacker Mk.2 variants with RR Avon or Tay engine, 1949.

WESTLAND

It is known that most of Westland's wartime project and design study brochures were still in existence after the war, but it appears that nearly all have now been destroyed. Fortunately a large 'chart' exists that outlines many of these projects together with brief details and a basic sketch.

Fighter Single-seat low/mid-wing fighter with one Bristol Perseus to F.5/34, 1935/36. Span 37ft 6in (11.4m).

Light Bomber General purpose bomber and reconnaissance aircraft to G.24/35, 1935.

P.9 Whirlwind Day fighter to F.37/35 first flown 11.10.38. Proposed development 11.39 with single Hercules in nose and 'controllable' guns in wing nacelles.

P.10 Torpedo and reconnaissance aircraft to S.24/37, 3.38.

Long-Range Fighter Alternative designs to F.6/39 with Griffon tractor or pusher engines, both 5.39.

Fleet Fighter Design studies to N.8/39 and N.9/39, 7.39 & 12.39.

Mass Production Fighter All-wood project to F.19/40, 11.39. One 1,400hp (1,044kW) Hercules as alternative to Merlin (if in short supply) and fixed spatted main wheels. Span 41ft 0in (12.5m), wing area 240ft^2 (22.3m^2), all-up-weight 7,200lb (3,266kg), top speed 336mph (541km/h).

P.13 High-altitude fighter to F.4/40, c9.40.

P.14 High-altitude fighter to F.4/40, c9.40. Resulted in Welkin first flown 1.11.42.

Light Bomber Short-range Delanne type project to B.7/40, 8.40.

Jet Whirlwind Design study for development of P.9 with two 1,800lb (8.0kN) Power Jets W2Bs, 1.41. Same wings and fuselage.

Close-Support Aircraft Dive bomber and tactical recce aircraft to B.20/40, 6.41.

High-Altitude Fighter Delanne type with 1,415hp (1,055kW) Griffon pusher engine, shaft drive and contra-props, 7.41. Span 50ft (15.2m), wing area 245ft^2 (22.8m^2), all-up-weight 11,000lb (4,990kg), maximum speed 400mph (644km/h) at 32,000ft (9,754m).

High-Altitude Jet Fighter Delanne type with two 1,800lb (8kN) Whittle W2B jets, 10.41. Span 42ft 6in (13.0m), wing area 180ft^2 (16.7m^2), all-up-weight 7,600lb (3,447kg), max speed 440mph (708km/h) at 35,000ft (10,668m).

Heavy Bomber Delanne project believed designed to B.8/41, 10.41.

High-Altitude Bomber Design study based on Welkin, possibly to B.5/41, c1942. Extended nose for radar (to be used for precision bombing) and two 2,000lb (907kg) bombs in former gun bay; wing of 20% greater chord considered. Two Merlin 76/77, span 70ft 0in (21.3m), all-up-weight 19,000lb (8,618kg), max. speed 380mph (611km/h). Mock-up only.

Ground Attack Aircraft Delanne type with tail booms, 2.42. One 1,400hp (1,044kW) Allison engine and two 40mm guns. Span 39ft (11.9m), wing area 200ft^2 (18.6m^2), all-up-weight 8,000lb (3,629kg), maximum 300mph (483km/h) at ground level.

J.8 Jet fighter based on Welkin with two Power Jets W2B/700, tunnel tested 11 & 12.42. Abandoned.

J.14 High-altitude jet fighter, 6.42.

Fighter Lightweight project to F.6/42, 2.9.42.

Jet Fighter J.15 twin-boom jet fighter (to E.5/42?), 10.42.

Heavy Bomber High-altitude design, 4.43. Sources suggest this was designed to B.3/42 but it had little in common with the requirement – was clearly intended to be a stratosphere bomber and, as such, appears to have lacked defensive guns. Powered by four Merlins intended to give 1,000hp (746kW) at 40,000ft (12,192m). Span 183ft (55.8m), wing area 2,800ft^2 (260.4m^2), cruise speed 190mph (306km/h) at 50,000ft (15,240m), range 1,500 miles (2,414km), bomb load 4,000lb (1,814kg), all up weight 45,000lb (20,412kg).

Torpedo Bomber Bomber-reconnaissance type to S.6/43, 4.43.

Naval Fighter Two twin-boom designs to N.7/43, 5.43. First, development of J.15 jet project with single DH H.1; second piston variant with one Griffon pusher.

Naval Bomber Combined piston/jet project to S.11/43, 8.43.

Fighter Bomber Mixed piston and jet-powered study to F.12/43, 5.44.

P.1056 and P.1061 Fighter-bomber projects, 3.44. Similar configurations with twin MetroVick F.2/4 jets in centre fuselage.

W.34 Wyvern long-range naval strike to N.11/44. RR 24.H46 Eagle piston engine, first flew 12.12.46. De-navalised variant prepared to F.13/44 but discontinued.

Jet Fighter Designs with Avon engine to F.11/45, 1.45.

W.35 Wyvern with RR Clyde or AS Python turboprop to N.12/45, first flew 18.1.49. Other proposed developments had Napier Nomad compound engine while S Mk.5 E of 3.54 had Napier E.141 Double Eland turboprop.

W.36 Wyvern development with 6,500lb (28.9kN) RR AJ.65 jet to N.12/45, 1946. Span 44ft (13.4m), length 41ft 9in (12.7m), wing area 355ft^2 (33.0m^2), all-up-weight fighter 16,500lb (7,484kg), striker 20,000lb (9,072kg). Fuselage and tail basically as W.34, tricycle undercarriage. Four 30mm Aden cannon. Later development had wide-chord inner wing of 360ft^2 (33.5m^2) area and either Avon or 7,000lb (31.1kN) MetroVick F.9.

Appendix Two

British 'Wartime' Fighter and Bomber Project Specifications

The Air Ministry has traditionally signalled to the British aircraft industry its expected future requirements via a series of specifications, against which tenders were usually invited.

Until the end of 1949 the sequential system used to issue these specifications was a letter/number/year arrangement. A typical example is B.1/35 which described a Heavy Bomber (in fact what became the Vickers Warwick): B stood for bomber; '1' indicated it was the 1st specification issued in that year, which was 1935. Alternative prefix letters included F (fighter), E (experimental), G (general purpose), M (torpedo bomber), N (naval) and P (light bomber); from about 1936 the lettering became more complex but the above description will suffice for this book. The reader should also note that specifications were not always put out to tender – for example there were a number of military types developed 'independently' during the period covered by this book, such as the Spitfire and the first jets, and each would have had a specification written around it.

Specifications for an aircraft required for military service were usually accompanied by an Operational Requirement with its own 'OR' number, for example OR.19 for B.1/35. Further details of pre-1950 specifications can be found in *The British Aircraft Specifications File* by Meekcoms and Morgan; details of ORs appeared in *Aeromilitaria*, issues 4/96 and 1/97 – all published by Air-Britain.

F.36/34 (OR.16) Fighter; Hawker Hurricane.
F.37/34 (OR.17) Fighter; Supermarine 300 Spitfire.
B.1/35 (OR.19) Heavy Bomber; Armstrong Whitworth AW.39, Boulton Paul P.79 variant, Bristol project, Fairey project, Gloster project, Handley Page HP.55, Vickers 284 Warwick. Airspeed AS.29 later.
F.9/35 (OR.20) Turret Fighter; Boulton Paul P.82 Defiant, Hawker Hotspur, Bristol 147, Supermarine 305, Armstrong Whitworth AW.34 development, Fairey project, Gloster project, Vickers Project.
M.15/35 (OR.22) Torpedo Bomber; Avro 672, Blackburn project, Boulton Paul P.83, Bristol 150, Handley Page and Vickers projects.
G.24/35 (OR.25) General Purpose Aircraft; Avro 675, Blackburn project, Boulton Paul P.84, Bristol project, Gloster project, Westland project.
28/35 (OR.26) Heavy Bomber; Bristol 142 Blenheim.
O.30/35 Fleet Fighter; Blackburn B.25 Roc, Boulton Paul P.85.
F.34/35 Turret Fighter; Gloster project.
F.37/35 (OR.31) Fighter; Bristol 153 & 153A, Boulton Paul P.88, Hawker Hurricane development, Supermarine 312 & 313, Westland P.9 Whirlwind.
R.1/36 (OR.32) Flying Boat; Blackburn B.20, Supermarine 314, Short project, Saro S.36 Lerwick.
M.7/36 Torpedo Recce Aircraft; Fairey Albacore.
10/36 (OR.28) General Purpose Aircraft (M.15/35 & G.24/35 combined); Avro, Blackburn B.26 Botha, Boulton Paul P.86, Bristol 152 Beaufort.
B.12/36 (OR.40) Heavy Bomber; Armstrong Whitworth AW.42, Boulton Paul P.90, Short S.29 Stirling, Supermarine 316, 317 & 318, Vickers 293. Bristol project later.
P.13/36 (OR.41) Medium Bomber; Avro 679 Manchester, Boulton Paul P.91, Bristol project, Fairey project, Handley Page HP.56, Hawker project, Shorts project, Vickers project.
F.9/37 (OR.49) Fighter; Boulton Paul P.89, Gloster G.39.
F.11/37 (OR.50) Turret Fighter; Armstrong Whitworth project, Boulton Paul P.92, Bristol project, Gloster project.
F.18/37 (OR.51) Fighter; Bristol Projects, Gloster projects, Hawker Tornado & Typhoon, Supermarine 324 & 325.
S.24/37 (OR.53) Torpedo Recce Aircraft; Blackburn B.21, B.29 & B.36, Bristol project, Fairey 100 (Barracuda), Hawker project, Supermarine 322 Dumbo, Westland P.10.
43/37 (OR.55) Engine Test-Bed; Folland Frightful, General GAL.43a, Percival P.26.
O.8/38 (OR.56) Fleet Fighter; Fairey Fulmar.
B.9/38 Twin-Engine Bomber; Armstrong Whitworth AW.41, Bristol 155.
B.17/38 Bomber; Bristol 155.
B.18/38 Bomber; Armstrong Whitworth AW.41 Albemarle.
B.1/39 Heavy Bomber; Armstrong Whitworth AW.48, Blackburn B.30, Avro 680, Bristol 159, Fairey & Gloster projects, Handley Page HP.60, Shorts S.34, Vickers 405.
R.5/39 (OR.69) Flying Boat; Blackburn B.32 & B.39, Saro S.38 & S.39, Short R.5/36, Supermarine 328.
F.6/39 Fighter; Supermarine 334, Vickers 414, Westland projects.
N.8/39 Fleet Fighter; **N.9/39** Fleet Turret Fighter and designs to **NAD925/39** Projects from Blackburn (B.31 & B.33), Fairey, Gloster, Hawker, Supermarine (including Type 333), Westland.
F.17/39 (OR.72) Fighter; Bristol 156 Beaufighter.
F.18/39 (OR.73) Fighter; Martin-Baker MB.3, MB.4 & MB.5.
F.22/39 (OR.76) Fighter; Vickers 414.
E.28/39 (OR.77) Jet Aircraft; Gloster G.39 Pioneer.
1/40 (OR.78) Recce Bomber; De Havilland DH.98 Mosquito, Folland Fo.113.
B.3/40 (OR.80) High-Speed Bomber; Blackburn B.28.
F.4/40 (OR.81) High-Altitude Fighter; General Aircraft GAL.46, Hawker P.1004, Westland P.13 & P.14 (Welkin).
5/40 (OR.82) Fleet Fighter; Fairey Firefly.
B.6/40 (OR.83) Support Bomber; Bristol 160 Blenheim V (Bisley Mk.I).
B.7/40 (OR.84) Medium Bomber; Armstrong Whitworth project, Hawker P.1001, Westland project.
F.9/40 (OR.86) Jet Fighter; Gloster G.41 Meteor.
N.11/40 (OR.88) Fleet Fighter; Blackburn B.37 Firebrand, Hawker P.1009.
R.13/40 Flying Boat; Blackburn B.40
R.14/40 (OR.91) Flying Boat; Saro S.41, Short S.35 Shetland.
F.16/40 Fighter; Vickers 420.
F.18/40 (OR.95) Night Fighter; Boulton Paul P.96 & P.97, Fairey project, Gloster G.39 variant, Hawker P.1008, Miles M.22A, Vickers project.
F.19/40 Fighter; Miles M.20, Westland project.
B.20/40 Support Bomber; Boulton Paul P.95, Fairey project, Hawker P.1006, Westland project.
F.21/40 (OR.96) Fighter; De Havilland DH.98 Mosquito.
E.28/40 (OR.101) 'Research Aircraft'; Folland Fo.115 & Fo.116.
B.2/41 Medium Bomber; Bristol 163 Buckingham.
E.6/41 (OR.107) Jet Fighter; De Havilland DH.100 Vampire.
F.7/41 (OR.108) Fighter; Vickers 432.
B.8/41 Heavy Bomber; Short S.36 Super Stirling, Westland project.
F.10/41 (OR.109) Fighter; Hawker P.1012 Tempest I.
B.11/41 (OR.110) Bomber; de Havilland DH.99 (became DH.101), Hawker P.1005, Miles M.39.
N.2/42 (OR.114) Boat Fighter; Blackburn B.44.
B.3/42 (OR.115) Heavy Bomber; Vickers 447 Windsor.
B.4/42 Bomber; De Havilland DH.102 'Mosquito II'.
E.5/42 Jet Fighter; Gloster G.A.1, Westland project.
F.6/42 Fighter; Airspeed AS.56, Boulton Paul P.99, P.100 & P.101, Folland Fo.117, Hawker P.1018, P.1019, P.1020 & P.1021 Tempest II, Supermarine project, Vickers project, Westland F.6/42.
H.7/42 (OR.117) Torpedo Bomber; Bristol project & 164 Brigand.
R.8/42 (OR.118) Flying Boat; Short S.45 Seaford.
No Official Specification Large Bomber; Two Avro projects, two Bristol projects, three Handley Page projects, three Shorts projects, five Vickers projects.
F.1/43 (OR.120) Fighter; Supermarine 371 Spiteful.
F.2/43 (OR.121) Fighter; Hawker P.1026 Fury.
O.5/43 (OR.144) Torpedo Bomber; Blackburn B.47, Cunliffe-Owen project, Fairey single and twin-engine projects (including Spearfish), Folland Fo.119.
No Official Specification Ground Attack Aircraft; Armstrong Whitworth AW.49, Boulton Paul P.99, P.100 & P.101, Cunliffe-Owen project, Martin-Baker project, Miles M.42, M.43 & M.44.
S.6/43 Torpedo Bomber; Armstrong Whitworth AW.53, Cunliffe-Owen project, Fairey project, Short Brothers project, Westland Project.
N.7/43 Naval Fighter; Boulton Paul P.103 & P.104, Fairey project, Folland Fo.118, Hawker P.1022, Westland projects.
S.8/43 (OR.124) Torpedo Fighter; Blackburn B.45 Firebrand Mk.III.
S.11/43 (OR.146) Naval Bomber; Armstrong Whitworth AW.54 & 54A, Blackburn project, Fairey project, Short S.38 Sturgeon, Westland project.
F.12/43 (OR.126) Fighter; De Havilland DH.103 Hornet, Westland project.
B.14/43 Heavy Bomber; Avro 694 Lincoln.
F.19/43 Fighter; Folland Fo.117A.
N.22/43 (OR.155) Naval Fighter; Hawker Sea Fury.
B.27/43 (OR.149) Heavy Bomber; Handley Page HP.66 Hastings.
S.28/43 (OR.150) Torpedo Fighter; Blackburn B.48 Firecrest.
E.1/44 (OR.157) Jet Fighter; Gloster G.42/G.A.2 Ace.
N.5/44 (OR.162) Naval Fighter; De Havilland DH.103 Sea Hornet.
E.6/44 (OR.170) Jet Boat Fighter; Saro P.113/SR.44/SR.A.1.
E.9/44 Research Aircraft; Armstrong Whitworth AW.52.
E.10/44 (OR.182) Jet Fighter; Supermarine 392.
O.21/44 Torpedo Bomber; Fairey Spearfish development.
N.11/44 (OR.174) Naval Fighter; Westland W.34 Wyvern.
E.1/45 (OR.195) Naval Jet Fighter; Supermarine 392 Attacker.
N.5/45 Naval Fighter; Supermarine 382 Seafang.
S.10/45 Torpedo Fighter; Blackburn B.48 Firecrest (Sabre engine).
F.11/45 Naval Jet Fighter; De Havilland Sea Vampire, Westland project.
N.12/45 (OR.213) Naval Fighter; Westland W.35 Wyvern.
N.16/45 Strike Aircraft; Fairey project.
N.21/45 (OR.226) Naval Night Fighter; De Havilland Sea Hornet Mk.21.
R.5/46 (OR.200) Patrol Bomber; Avro 696 Shackleton.
N.7/46 (OR.218) Naval Jet Fighter; Hawker P.1040 Sea Hawk, Short S.41/SA.3(?).
E.38/46 (OR.243) Research Aircraft; Hawker P.1052.
E.41/46 Research Aircraft; Supermarine 510.
R.2/48 (OR.231) Flying Boat; Saro P.104, Shorts P.D.2 & modified Shetland, Supermarine 524.
F.24/48 (OR.265) Night Fighter; Armstrong Whitworth Meteor Mk.11.
15/49 (OR.277) Strike Fighter; De Havilland DH.112 Venom.

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Appendix Three

British 'Wartime' Fighter and Bomber Contracts

Serial(s)	*Type*	*Contract*	*Date*	*Comments*
K4049	Vickers B.9/32	274142/33	12.12.33	Wellington
K4190	Fairey S.15/33 (TSR)	280480/33		Swordfish
K4240	Handley Page B.9/32	274141/33		Hampden
K4299	Armstrong Whitworth AW.29	321542/34	11.6.34	P.27/32
K4303	Fairey P.27/32	321541/34		Battle
K4586/K4587	Arm. Whitworth AW.38	349065/34	9.6.34	Whitley
K4773	Saro A.33 (R.2/33)	351563/34		
K4774	Short S.25 (R.2/33)	351564/34		Sunderland
K5054	Supermarine F.37/34	361140/34		Spitfire
K5061	Armstrong Whitworth F.5/33	356293/34	4.1.35	two-seat fighter, see K8624
K5083	Hawker F.36/34	357483/34	21.2.35	Hurricane
K5099	Fairey P.4/34	370875/34	3.5.35	Fulmar
K5115	Hawker P.4/34	370869/34		Henley
K5117	Avro O.27/34	385170/35		Avro 666
K5119	Bristol F.5/34	395998/35	25.3.35	Bristol 146
K5177	Vickers O.27/34	400779/35		Vickers 280
K5178/K5179	Blackburn O.27/34	400778/35		Skua
K5200	Gloster SS.37 (F.7/30)	395996/35	25.3.35	Gladiator
K5604	Gloster F.5/34	395999/35	14.5.35	
K7554	Hawker P.4/34	370869/34		see K5115
K7555	Fairey P.4/34	370875/34		see K5099
K7556	Vickers G.4/31 PV	436890/35		Wellesley
K8088	Bristol F.5/34	395998/35		see K5119
K8089	Gloster F.5/34	395999/35		see K560
K8178	Vickers B.1/35	441973/35	7.10.35	Warwick
K8179	Armstrong Whitworth B.1/35	441974/35	7.10.35	some sources quote as HP
K8180	Handley Page B.1/35	441975/35	7.10.35	some sources quote as AW
K8309	Hawker F.9/35	453461/35	7.11.35	Hotspur
K8310	Boulton Paul F.9/35	453462/35	7.11.35	Defiant
K8620	Boulton Paul F.9/35	453462/35	13.1.36	
K8621	Hawker F.9/35	453461/35	24.1.36	
K8622/K8623	Fairey F.9/35	453463/35	1.2.36	
K8624	Armstrong Whitworth F.9/35	490715/35	12.2.36	AW.34 (K5061 cancelled same day)
K8625	Gloster F.5/33	450108/35	8.2.36	some sources say F.34/35
L6591/6592	Boulton Paul F.37/35	556966/36	7.12.36	cancelled 6.1.37
L6593	Supermarine F.37/35	556964/36	7.12.36	cancell'd 28.1.37
L6844/6845	Westland F.37/35	556965/36	11.2.37	Whirlwind
L6889/6890	Supermarine B.12/36	605350/37		
L7244/7245	Handley Page P.13/36	624972/37	30.4.37	
L7246/7247	Avro P.13/36	624973/37	30.4.37	Manchester
L7269	Bristol 143	536795/36		
L7600/L7605	Short B.12/36	672299/37		Stirling
L7625/L7628	Fairey S.9/36	681749/37		
L7999/L8001	Gloster F.9/37	697972/37	4.2.38?	
L9629/L9632	Boulton Paul F.11/37	708600/37	2.3.38	
L9704	Vickers B.1/35	734772/38		see K8178
P1767/P1770	Fairey S.24/37	777067/38		Barracuda
P5212/P5216) P5219/P5224)	Hawker F.18/37	815124/38		Typhoon and Tornado
P9594	Martin Baker MB.2	982598/39		stated to be 'F.5/34'
R1810/R1815	Supermarine S.24/37	976687/39		'Dumbo'
R2492/R2496/R2500	Martin Baker F.18/39	1165/39		
R2659	Short Stirling with cannon turrets	2596/39		) Armament
R2665	H Page Halifax with cannon turrets	10713/39		) development
R2671	Avro Manchester with cannon turrets	7625/39		) aircraft (?)
R4236/R4239	Vickers F.22/39	17894/39		
T9124	Handley Page Halifax	987458/39		No details known
V3142	Heston model of B Paul P.92	B.19037/39		
V8914	Blackburn R.1/36	498571/36		
V9258	Boulton Paul F.11/37 (P.92)	498571/36		See L9629 etc
W4041/W4046	Gloster E.28/39	SB.3229		
X2871/X2875	Bristol B.1/39	B.62051/39	7.5.40	
X2880/X2885	Handley Page B.1/39	B.62052/39	7.5.40	
X8500	Blackburn B.3/40 (B.28)	B.81965/40	6.6.40	
AA276/AA279	Bristol Bisley (Rootes)	B.124276/40	28.6.40	later became DJ702/DJ707
AD657/AD661	Bristol Bisley (Bristol)	B.69276/40		
AX834	Miles M.20/2	B.140247/40	N.1/41	
BT308	Avro Manchester III	B.135521/40		
DD804/DD810/DD815	Blackburn N.11/40	B.156337/40	27.1.41	Firebrand
DG202-DG213	Gloster F.9/40	SB.21179		Meteor
DG558/DG562	Westland F.4/40	C/Acft/633		Welkin
DG595	Avro Lancaster	B.135521/40		
DJ702/DJ707	Bristol Bisley (Rootes)	B.124276/40		see above
DP845/DP851	Supermarine F.4/41	C/Acft/821	26.5.41 ?	
DR616	Miles N.1/41	B.140247/40		
DT810	Avro Lancaster	B.135521/40		DT812 did not exist
DW506/DW512	Vickers B.5/41	C/Acft/1153	15.7.41	
DX160/DX165	Folland E.28/40	C/Acft/741	15.8.41	
DX166/DX171	Saro/Short R.14/40	Contract number not quoted in Ministry ledger		
DX249/DX255/DX259/DX266	Bristol B.2/41	C/Acft/236		Buckingham
DZ217/DZ223	Vickers F.7/41	C/Acft/1346		Vickers 432
ES966/ES979	Blackburn R.13/40	C/Acft/1474	19.9.41	Blackburn B.40
HG641	Hawker Tornado	SB.21392.		
HM595/HM599	Hawker F.10/41	SB.32483		Tempest
HV266/HV270	Hawker B.11/41	C/Acft/1712		P.1005
JR540/JR543	Short B.8/41		14.2.42	Contract number not quoted
LA594/LA597/LA602/LA607/LA610/LA614	Hawker Tempest?	C/Acft/1986		
LZ548/LZ551	De Havilland E.6/41	SB.24539		Vampire
MP478/MP481	De Havilland B.4/42	C/Acft/1955		DH.102
MP829/MP832	Vickers B.3/42	SB.24954	4.7.42	
MP838	De Havilland E.6/41	SB.24539		
MX988/MX991/MX994/MX997	Bristol H.7/42	SB.25383		Brigand
MZ269/MZ271	Short R.8/42	C/Acft/2551		S.45 Seaford
MZ275/MZ277	Blackburn N.2/42	C/Acft/2542		Blackburn B.44 (originally C/Acft/2189, 19.5.42)
NK136	Vickers B.3/42	C/Acft/1153		Windsor
NN648/NN651/NN655	Gloster E.5/42	SB.26236	29.1.43	Cancelled 7.2.44
NN660/NN664/NN667	Supermarine F.1/43	C/Acft/2329	1.2.43	Spiteful
NN670/NN673	Vickers B.3/42	C/Acft/1153	2.2.43	Windsor
NS487/NS490/NS493	Supermarine Seafire XV	C/Acft/2901	8.3.43	
NV636	Blackburn Firebrand	ledger states 'Ref. DD810'; no contract number		
NX798/NX802	Hawker F.2/43	No number	22.3.43	Fury
PF370/PF376	Westland F.9/43	SB.26569	29.4.43	Welkin II
PK240/PK243/PK245	Supermarine N.4/43	C/Acft/2901	24.5.43	
PP139	Supermarine Spitfire 21	C/Acft/821	5.7.43	
PW925/PW929/PW932	Avro Lancaster IV	C/Acft/3183	19.7.43	Lincoln
RA356/RA360/RA363	Fairey O.5/43	SB.26862	13.8.43	Spearfish
RD104/RD107/RD108/ RD113/RD115/RD118	Eng Elec F.6/42	SB.26924	10.9.43	Folland Fo.117A
RN241	Fairey T.21/43	No number	3.11.43	Spearfish trainer
RK787/RK791/RK794	Short S.11/43	SB.27016	19.10.43	Sturgeon
RR910	Miles M.39	C/Acft/3461	12.11.43	
RR915/RR919	De Havilland F.12/43	SB.26873	12.11.43	Hornet
RT133/RT136	Miles E.24/43	SB.27157	15.12.43	Miles M.52
RT646	Supermarine 'Spitfire VIII'	C/Acft/2329	24.12.43	Seafang
RT651/RT656	Blackburn S.28/43	SB.27216	1.1.44	'Firecrest' (Ledger gives 'Fairey S.28/43')
RT661	Westland F.9/43	SB.26569	6.1.44	Welkin II
SM801/SM805/SM809	Gloster E.1/44	SB.27324	7.2.44	Ace
SR392	Miles M.39B	none given	12.2.44	See RR910
SR650/SR654/SR657	Handley Page B.27/43	C/Acft/3401	24.2.44	HP.66
SR661/SR666	Hawker N.22/43	SB.27022	24.2.44	Sea Fury
SX549	Supermarine 'Spitfire F.21 2nd version'	SB.27489	6.4.44	
SX553	Handley Page B.27/43	C/A/3401	7.4.44	HP.66
TG263/TG267/TG271	Saro E.6/44	C/Acft/4122		
TJ175/TJ179/TJ184	Fairey O.5/43	SB.26862	22.5.44	
TM379/TM383/TM389	Supermarine Spitfire F.21	B.981687/39		'to be navalised'
TS371/TS375/TS378/TS380/TS384/TS387	Westland N.11/44	C/Acft/4522	26.8.44	Wyvern
TS409/TS413/TS416	Supermarine E.10/44	C/Acft/4562	30.8.44	Attacker
TS444/TS449/TS455	De Havilland Sea Mosquito	C/A/4668	23.9.44	
TX145/TX148/TX150	Gloster E.1/44	SB.27324	26.1.45	Ace
TX374	Bristol Brigand	C/A/2903	16.2.45	
VB847	Hawker N.22/43	SB.27022		Sea Fury
VB893/VB895	Supermarine N.5/45	C/Acft/5176	12.3.45	Seafang
VD258/VD261/VD264/VD269	Fairey O.21/44	C/Acft/5173	5.4.45	Spearfish development
VF172	Blackburn S.28/43	SB.27216		'Firecrest'
VF254/VF257/VF262	Blackburn S.10/45	SB.84896		Sabre 'Firecrest'
VP109/VP113/VP120	Westland N.12/45	C/Acft/5982	7.2.46	Wyvern turboprop
VP401/VP413/VP422	Hawker P.1040	C/Acft/6115	30.3.46	Sea Hawk
VP988/VR104/VR123	Fairey N.16/45	6/Acft/378	20.6.46	
VV106/VV109	Supermarine 510 (E.41/46)	6/Acft/1031	4.3.47	Swept Attacker
VW126/VW131/VW135	Avro 696 (R.5/46)	6/Acft/1077		Shackleton
VX272/VX279	Hawker P.1052 (E.38/46)	6/Acft/1156	23.3.48	Swept P.1040
WA546	AWA Meteor (F.24/48)	6/Acft/3437	31.5.49	Night fighter

This list covers prototypes and unbuilt designs only; there are no production aircraft. The date gives the point where serials were allocated and comes from the Ministry's serial ledger. It should fall very close to the date of an ITP, which was the official authority to spend money, but some of the dates given fall after the start of work on their particular project, even to the point where preparations were under way for metal bashing. In such cases the firm concerned may have begun its work as a private venture or short-term contracts may have proceeded the ITP.

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